

modern castings

APRIL 1958



CONVENTION PREVIEW ISSUE

Preview
62ND.
CASTINGS
CONGRESS

Preview
OF THE
SHOW

Preview
OF
PLANT
TOURS



PROVED BY INDEPENDENT LABORATORY TESTS:

63% S·M·I*

for FERROCARBO®-TREATED MALLEABLE IRON

These important test results were obtained by a widely-known independent research laboratory on malleable iron castings produced by a large Midwest foundry, using untreated and FERROCARBO-treated iron of identical chemistry.

Chemical Analyses	Untreated	Ferrocarbo® Treated	STOCK REMOVAL
TC _____	2.48	2.48	
Si _____	1.30	1.40	
Cutting speed (ft./min.)	185	185	
Feed (in./rev.)	.009	.009	
Depth of cut (in.)	.062	.062	
Wear Land (in.)	.060	.060	
Vol. of metal removed (cu. in.)	20.4	33.1	
Weight of metal removed (lbs.)	5.2	8.5	
Percent improvement		63.0%	

* Surface Machinability Improvement
Tool wear tests were conducted with high speed tools of the M-2 type on castings machined at commercial speeds. Flank wear was measured with a 20 power microscope.

MALLEABLE IRON FOUNDRIES are now assured of superior castings regardless of the melting process—whether cupola, duplex, or air furnace—by the use of FERROCARBO, the patented additive by CARBORUNDUM. Various machining tests conducted under controlled conditions prove conclusively that FERROCARBO deoxidation makes possible the reduction or complete elimination of many of the casting difficulties experienced with undeoxidized malleable iron. For example...

- **INCREASED FLUIDITY** is readily apparent. Tests show a fluidity spiral increase over untreated irons. This means less mis-run castings.
- **GRAIN STRUCTURE** is also considerably improved with the dendritic pattern less pronounced in the test sprue. This means more uniform analysis, particularly in cupola or duplex operations.
- **MORE STEEL SCRAP** can be used and improved machinability obtained. This means better castings at less cost.

WRITE FOR MORE INFORMATION on how FERROCARBO produces more machinable iron regardless of metal composition. Ask for booklet A-1409, Electro Minerals Division, The Carborundum Company, Niagara Falls, N. Y.

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Circle No. 721, Page 7-8

future meetings
and exhibits

APRIL

9-10 . . Malleable Founders' Society, *Market Development Conference*. Edge-water Beach Hotel, Chicago.

13-18 . . American Chemical Society, *Spring Meeting*. San Francisco.

14-15 . . American Society of Mechanical Engineers, *Maintenance & Plant Engineering Conference*. Penn-Sheraton Hotel, Pittsburgh, Pa.

14-15 . . American Zinc Institute, *Annual Meeting*. Chase-Park & Plaza Hotels, St. Louis.

14-16 . . American Institute of Mining, Metallurgical & Petroleum Engineers, *41st National Open Hearth Steel Conference*. Statler Hotel, Cleveland.

14-17 . . American Society of Mechanical Engineers, *Design Engineering Conference*. International Amphitheatre, Chicago.

14-18 . . American Welding Society, *Annual Meeting & 6th Welding Show*. Kiel Auditorium and Statler Hotel, St. Louis.

15 . . Metallurgical Associates, Inc., *Sales Clinic*. Hotel Sheraton, Springfield, Mass.

19-25 . . *Industrial Health Conference*. Convention Hall, Atlantic City, N. J.

21-23 . . Association of Iron and Steel Engineers, *Spring Conference*. Dinkler-Tutwiler Hotel, Birmingham, Ala.

21-26 . . American Industrial Hygiene Association, *Annual Meeting*. Claridge Hotel, Atlantic City, N. J.

23-25 . . American Management Association, *Conference on Plant Location*. Roosevelt Hotel, New York.

27-30 . . Chamber of Commerce of the United States, *Annual Meeting*. National Chamber Bldg., Washington, D. C.

27-May 1 . . American Ceramic Society, *Annual Meeting*. Penn-Sheraton Hotel, Pittsburgh, Pa.

27-May 2 . . The Electrochemical Society, *Technical Sessions*. Hotel Statler, New York.

MAY

1-8 . . American Society of Tool Engineers, *26th Annual Meeting & Convention*. Convention Center, Philadelphia.



VISIT OUR BOOTH at the 62nd Castings Congress and Foundry Show (Booth 524) Cleveland, May 19-23.



84-83 R

8-10 . . American Material Handling Society, *Western Material Handling Show*. Great Western Exhibit Center, Los Angeles.

12-16 . . American Society for Metals, *1st Southwestern Metal Congress & Exposition*. State Fair Park, Dallas, Texas.

13-15 . . Investment Casting Institute, *Annual Spring Meeting*. Edgewater Beach Hotel, Chicago.

14-16 . . National Industrial Sand Association, *Annual Meeting*. The Homestead, Hot Springs, Va.

19-20 . . Non-Ferrous Founders' Society, *Annual Meeting*. Carter Hotel, Cleveland.

19-23 . . American Foundrymen's Society, *62d Annual Castings Congress & Foundry Show*. Public Auditorium, Cleveland.

21-22 . . American Iron and Steel Institute, *Annual Meeting*. Waldorf-Astoria Hotel, New York.

JUNE

5 . . AFS Division Meetings, Executive and Program & Papers Committees, *Annual Review*. Sherman Hotel, Chicago.

6 . . AFS Technical Council, *Annual Meeting*. Sherman Hotel, Chicago.

9-10 . . Malleable Founders' Society, *Annual Meeting*. The Homestead, Hot Springs, Va.

9-12 . . American Society of Mechanical Engineers, *National Materials Handling Conference*. Public Auditorium, Cleveland. *Held in conjunction with Materials Handling Exposition*.

9-13 . . *International Automation Exposition & Congress*, Coliseum, New York.

12-13 . . AFS 15th *Annual Chapter Officers Conference*. Hotel Sherman, Chicago.

16 . . AFS Publications Committee, *Annual Meeting*. Sherman Hotel, Chicago.

18-28 . . Iron and Steel Institute, *International Meeting*. Belgium and Luxembourg.

19-21 . . AFS 3d *Annual Foundry Instructors Seminar*. Case Institute of Technology, Cleveland.

20 . . AFS T&RI Research Committee, *Annual Meeting*. Sherman Hotel, Chicago.

22-27 . . American Society for Testing Materials, *61st Annual Meeting*. Hotel Statler, Boston.

27 . . AFS Exhibits Committee, *Annual Meeting*. Sherman Hotel, Chicago.

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JULY

21... AFS T&RI Trustees, *Annual Meeting*. Union League Club, Chicago.

22-23... AFS Finance Committee, *Annual Meeting*. Union League Club, Chicago.

AUGUST

7... AFS Executive Committee, *Special Meeting*. Sherman Hotel, Chicago.

7-8... AFS Board of Directors, *Annual Meeting*. Sherman Hotel, Chicago.

SEPTEMBER

10-11... American Die Casting Institute, *Annual Meeting*. Edgewater Beach Hotel, Chicago.

22-23... Steel Founders' Society of America, *Fall Meeting*. The Homestead, Hot Springs, Va.

23-26... Association of Iron and Steel Engineers, *Exposition*. Public Auditorium, Cleveland.

29-Oct. 3... Association Technique de Fonderie de Belgique, *25th International Foundry Congress*. Brussels and Liege, Belgium.

OCTOBER

5-8... National Association of Corrosion Engineers, *Annual Meeting, Northeast Regional Division*. Somerset Hotel, Boston.

8-10... Gray Iron Founders' Society, *Annual Meeting*. Sheraton Park Hotel, Washington, D. C.

15-16... AFS *Michigan Regional Foundry Conference*. University of Michigan, Ann Arbor, Mich.

16-17... AFS *All Canadian Regional Foundry Conference*. Royal Connaught Hotel, Hamilton, Ont.

16-18... Foundry Equipment Manufacturers Association, *Annual Meeting*. The Greenbrier, White Sulphur Springs, W. Va.

17-18... AFS *New England Regional Foundry Conference*. Massachusetts Institute of Technology, Cambridge, Mass.

27-31... American Society for Metals, *National Metals Exposition & Congress*. Public Auditorium, Cleveland.

30-31... AFS *Purdue Metals Casting Conference*. Purdue University, Lafayette, Ind.

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modern castings

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MODERN CASTINGS is indexed by Engineering Index, Inc., 29 West 39th St., New York 18, N. Y. and microfilmed by University Microfilms, 313 N. First St., Ann Arbor, Mich.
The American Foundrymen's Society is not responsible for statements or opinions advanced by authors of papers or articles printed in its publication.
Published monthly by the American Foundrymen's Society, Inc., Golf & Wolf Roads, Des Plaines, Ill. Subscription price in the U.S., \$5.00 per year; elsewhere, \$7.50. Single Copies 50c. April, May and June issues \$1.00. Entered as second-class mail at Pontiac, Illinois. Additional entry at Des Plaines, Ill.



Horizons Unlimited

Ours is a big industry—and a basic one—one that is absolutely essential to our industrial growth. In 1956, for instance, foundries in the United States employed over 450,000 people and did a business over \$6,591,000,000. Limitless opportunities in the cast metals industries are open to us if we have the will and the wisdom to rise to our tomorrows.

Our "tomorrow," however, will take a lot of doing! "Nothing can destroy a business so completely as a new and better product in the hands of a competitor," said J. Earl Gulick, vice-president of manufacturing, B. F. Goodrich Co., Akron, Ohio. That is most assuredly true in the case of cast products. We must also agree with another statement of Mr. Gulick—that the best defense is an aggressive offense.

That aggressive offense can be achieved by three fundamental approaches: 1) technical research, both basic and applied; 2) market research, both product development and long-term; and 3) education, both vocational and college.

Technical research is the life blood of our industry or of any industry. Without it we wither on the vine. All in all, the technical research picture leaves much to be desired. We do not have a complete all-inclusive figure representing all technical research expenditures for our cast metals industry. However we do know that, except for private research, a total of only about \$268,000 was spent last year by technical societies against an estimated industry sales in 1956 of \$6,591,000,000—an infinitesimal 0.00004 cents to each sales dollar. This isn't good, and bodes ill for our tomorrows unless we are much more farsighted in supporting our research activities.

Nowhere in the realm of opportunity is there greater promise for foundry people than in product and market development. The country is full of weldments, machined parts, forgings and fabrications that should be castings.

What is the long-term outlook for our products? Back in 1952 the Paley Commission came up with the prediction that the demand for iron castings in 1975 will represent a 26 per cent increase over the actual production of iron castings in 1950. Because it becomes so important from a planning standpoint to have a reasonably accurate idea as to what we can expect, more should be done by this industry in its long-term market research activities. It should receive equal consideration with technical research, both in time, money, and effort.

I think it is axiomatic to say that our future is directly geared to the ability of the people who are leading the way. And these people, with rather obvious exceptions, should come from our universities and graduate institutions. Fortunately, a worthy effort is being made in this direction. The Foundry Educational Foundation is doing the best it can with a limited budget to sponsor foundry engineering education in a group of some 17 topflight universities or engineering colleges. Twelve AFS student chapter activities are most valuable in adding brain power—and leaders of tomorrow—to our industry. Other fine organizations are doing a grand job at the college level.



By expanding our technical and market research and encouraging education, OUR HORIZONS ARE TRULY UNLIMITED!

ALLEN M. SLICHTER / President
Pelton Steel Casting Co.
Milwaukee

Announce Process for Foaming Mg-Al Alloys

■ Techniques and equipment which produce metal foam for sandwich construction have been developed as a result of a project for the Air Force to determine whether metal foam superior to plastic foams could be produced. The metal foam technique has recently been released to industry through the Office of Technical Service U. S. Dept. of Commerce.

Preliminary work demonstrated the feasibility of foaming magnesium-aluminum alloys. The most effective procedure involved a prior preparation of a mixture of magnesium-aluminum eutectic alloy and titanium or zirconium hydride as the foaming agent.

The foaming procedure consists of melting the metal to be foamed, stirring in the foaming agent, releasing hydrogen from the hydride, and solidifying the foamed metal.

An important development during the course of the project, which improved quality of low density metallic foam, involved introducing air or oxygen into the foamed mixture prior to its solidification.

Aluminum oxide-coated steel, because of its high corrosion resistance to molten aluminum, magnesium, and their alloys, has been introduced as a structural material for certain components of the foaming equipment. According to the three-part report, *Foamed Metal Low Density Core Material for Sandwich Construction*, further improvement in quality and uniformity of the product depends largely on construction of pilot plant equipment capable of providing a more truly continuous flow of foam in larger quantities.

■ For additional information about this new process, circle No. A, Reader Service Card, p. 7-8.

Foundry Occupations and Future a U. S. Pamphlet

■ Foundry occupations, with a look to future demand for specialists in foundry trades, are described in a recent United States Dept. of Labor publication available for 15 cents.

Employment Outlook in Foundry Occupations, includes an introduction to the nature of foundry work, foundry processes, training and qualifications, earnings, and working conditions; and also deals specifically with the occupations of molder, core-maker, and patternmaker.

■ For additional information about this new process, circle No. D, Reader Service Card, p. 7-8.



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Circle No. 724, Page 7-8



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Ceramic Coatings Increase Utility for Many Metals

■ Aircraft manufacturers are discovering many uses for ceramic coatings on their heat-resistant castings and other components such as cooling caps, combustion chambers, flame domes, flame nozzles, super-charger housings, after-burner lines, and exhaust pipes, primarily because ceramic coating of these parts offers continuous protection against oxidation at temperatures up to 1700 F, and resists oxidation for moderate durations up to 2150 F.

According to F. D. Shaw, Bettinger Corp., Waltham, Mass., other ceramic coating properties include excellent abrasion resistance, achieving a surface hardness considerably harder than brass, aluminum, copper, and many forms of steel and steel alloys. Such coatings also act as a fluxing agent, permitting arc and gas welding through the coating surface. A very thin coating, permitting rapid heat transfer, provides good protection at high temperatures.

Perhaps the greatest use of ceramic coatings is on castings needing resistance to corrosion such as attack by acidic solutions or vapors. It is more practical to use ceramic coated parts for resistance to corrosion at higher temperatures than to use plastics, which are limited in use at temperatures above 200 F.

■ For additional information about this new process, circle No. B, Reader Service Card, p. 7-8.

Declares Industry Should Assist Technical Students

■ The belief that industry, which employs the great majority of scientists, has therefore an obligation to assist future scientists in completing their education, was recently reaffirmed by T. L. Daniels, Archer-Daniels-Midland Co., Minneapolis.

Declaring that a large share of the responsibility for maintaining the United States' leading position in scientific development rests with business, the company recently expanded its student award program of science fellowships and scholarships by creating a new chemistry scholarship at Mankato State College, Mankato, Minn.

Seventeen students now are studying chemistry, chemical engineering, and the technology of human and livestock nutrition under the ADM educational program. The company has provided 107 grants since beginning the program five years ago; individual grants range up to \$2500 a year, and are maintained at 15 American colleges and universities.



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Circle No. 726, Page 7-8

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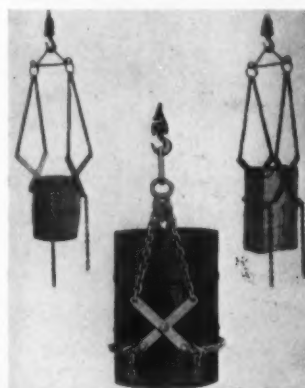
Build an idea file for plant improvements.
The post-free cards on page 7-8
will bring more information on these new . . .

products and processes

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under oil and greasy surfaces, and is said to protect rust-free surfaces from rusting during inside storage. *Service Industries.*

For Manufacturer's Information
Circle No. 603, Page 7-8



PORTABLE MELTING FURNACE . . . claimed to eliminate coasting-over as lining stores no heat. Uses 3-5 gal of oil per hour of melting; holds metal at correct pouring temperature; and needs no outside flue. Capacity 150-300 lb. *Industrial Scale & Equipment Co.*

For Manufacturer's Information
Circle No. 604, Page 7-8

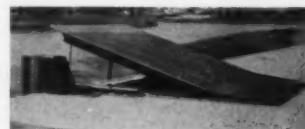
INSPECTION LIGHTS . . . designed for use in industrial inspection equipment to produce clear beam of light said to be free of filament shadows found in lights using flashlight lamps. Equipment designed for inspecting



weight increases. One ton and half ton standard sizes; larger sizes for special requirements. *Palmer-Shile Co.*

For Manufacturer's Information
Circle No. 601, Page 7-8

AUTOMATIC DOCKBOARD . . . said to be installed without expensive alterations to existing truck docks; no electrical, air, or hydraulic power required. No dock attendant needed; backing truck automatically lowers



ramp to proper position which compensates for uneven truck beds; and returns to original position after loading complete. *Kelley Co.*

For Manufacturer's Information
Circle No. 602, Page 7-8

RUST REMOVING SOLVENT . . . removes rust from iron, steel, and special alloy castings. Guaranteed by manufacturer to remove rust from precision parts without harm. Said to be only solvent available which does not burn, distort, etch, or change tolerances of metal. Removes rust

cavities in castings which could not otherwise be inspected visually. Available with extension shafts, rotatable mirrors, magnifying lenses, and directional caps. Self contained power source. *Welch Allyn, Inc.*

For Manufacturer's Information
Circle No. 605, Page 7-8

SPECTROMETER . . . permits analysis of C, P, and S simultaneously with Si, Mn, and other metallics in steel and cast iron. Designed for direct-reading analysis in the region 1600 to 3300A. *Applied Research Laboratories.*

For Manufacturer's Information
Circle No. 606, Page 7-8

METAL REMOVAL TORCH . . . for heavy-duty foundry applications

FOUNDRYMEN FIND TREASURE OF 3253 NUGGETS (of information)

(SPECIAL) Readers of MODERN CASTINGS magazine are reported to have uncovered a treasure-trove of 3253 valuable catalogs and data sheets in the February, 1958, issue of the publication. The discovery was made with the assistance of the Reader Service Cards printed in the magazine.



Foundrymen are shown rushing to share in treasure of valuable information available by using the Reader Service Cards in MODERN CASTINGS.

The alert foundrymen who read MODERN CASTINGS sent the magazine 3253 requests for further information on products or services described in the February issue. Manufacturers' bulletins and catalogs were dispatched in answer to those requests.

It is reported that more and more foundrymen are mining valuable information with the aid of these Reader Service Cards. Records of the magazine show that the number of requests is rising rapidly.

Usually reliable sources report that there is still an opportunity for more foundrymen to join this monthly Gold Rush, since the system developed by the magazine to expedite requests can handle still more inquiries.

To request information on products described in PREVIEW OF TOOLS FOR TOMORROW, pages 30-39, circle number that corresponds to illustration number in the article. If item did not have an illustration, state manufacturers' name on line provided.

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Mfr's. name _____

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Every month take the opportunity to meet the leading scientific and management personalities of the metalcastings industry by reading their articles in **modern castings**.

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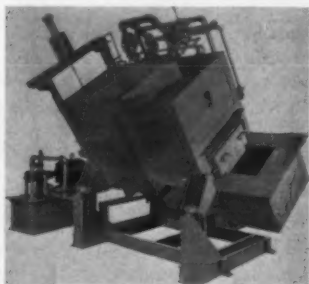
To request information on products described in PREVIEW OF TOOLS FOR TOMORROW, pages 30-39, circle number that corresponds to illustration number in the article. If item did not have an illustration, state manufacturers' name on line provided.

■ Details on these products and processes are available to MODERN CASTINGS readers. See page 7-8.

such as riser stub and flash removal, and pad washing. Air jets on both sides of electrode for increased maneuverability. Uses 1/2, 5/8, and 3/4-in. electrodes. Heat shield protects operator's hand; push button air control. *Arcair Co.*

For Manufacturer's Information
Circle No. 607, Page 7-8

NOSE POUR FURNACE . . . with hydraulic tilting mechanism for pouring large sand castings or transferring molten metal to holding furnace or ladle. Larger sizes have dip-out



vestibule in addition to pouring spout. Double-chamber, dry-hearth design, said to produce hydrogen-free metal, assuring stronger castings without porosity. Capacities are 600, 750, 1000, and 2000 lb per hour. *Eclipse Fuel Engineering Co.*

For Manufacturer's Information
Circle No. 608, Page 7-8

DIRECT READING CALIPER . . . saves time in measuring parts and materials. Measures irregular castings up to 4 in. thick. Size is read directly



on scale calibrated in 32ds of an in. Readings three in. from edge of work possible. *Master Specialty Co.*

For Manufacturer's Information
Circle No. 609, Page 7-8

AUTOMATIC DIE CASTING . . . machine said to improve quality and finish of castings over manually operated machines. Automatic operations include machine cycling, die cleaning and lubricating, inspection, water

FOR
UNIFORM
SHELL MOLD
STRUCTURE
SPECIFY
RCI'S FOUNDREZ 7500



FOUNDREZ 7500 is a very finely powdered thermosetting phenolic resin. You will find that it blends easily, gives uniform shell mold structure and strength in economical sand-to-resin ratios.

When you produce shell molds with **FOUNDREZ 7500**, you reduce curing cycles. This remarkable RCI resin performs satisfactorily at extremely high oven temperatures, lets you turn out more molds per hour.

While **FOUNDREZ 7500** works well in almost all applications, it is especially recommended for tough and intricate jobs where the

patterns have a deep draw, and where the sand must flow, fill and bake extra well.

FOUNDREZ 7504 is very similar to **FOUNDREZ 7500** but is faster setting and intended for use in high speed production. It generally gives a more rigid shell mold than **FOUNDREZ 7500**.

For large and small parts cast with any ferrous or non-ferrous material, shell molding with **FOUNDREZ 7500** and **7504** is ideal . . . particularly for long production runs. For technical help or complete information, write to RCI Foundry Division in White Plains.

Creative Chemistry . . .



Your Partner in Progress

REICHHOLD

Synthetic Resins • Chemical Colors • Industrial Adhesives • Plasticizers
Phenol • Formaldehyde • Glycerine • Phthalic Anhydride • Maleic Anhydride
Sodium Sulfite • Pentaerythritol • Pentachlorophenol • Sulfuric Acid

REICHOLD CHEMICALS, INC., RCI BUILDING, WHITE PLAINS, N. Y.

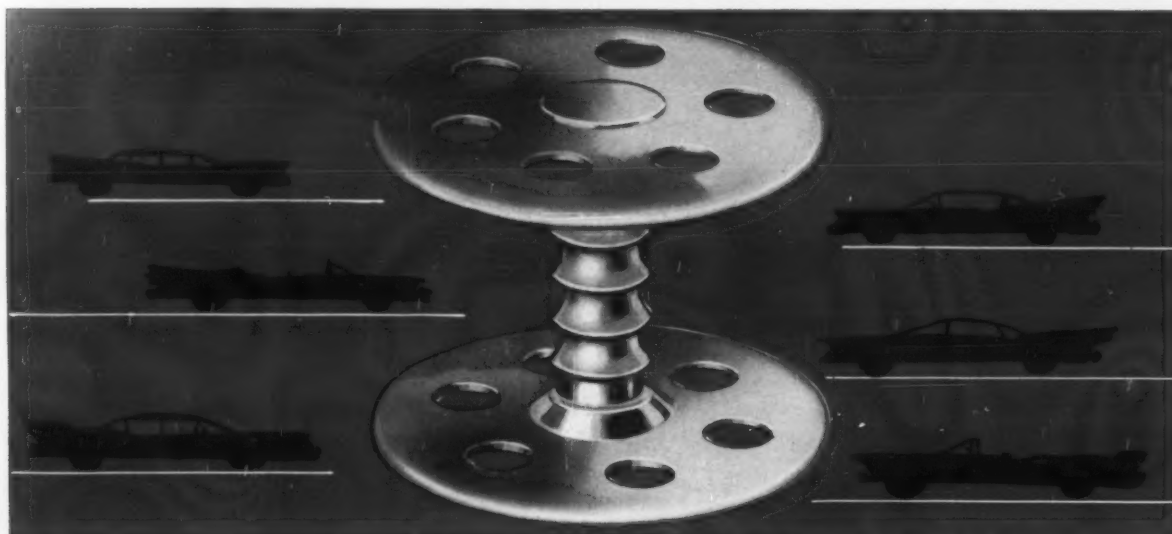
Circle No. 727, Page 7-8

*automobile
styles may
change...*

but motor car manufacturers unanimously choose

fine **FANNER**

DOUBLE MOTOR CHAPLETS
HEAD
for producing sound, uniform castings

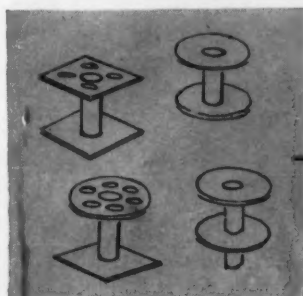


The tremendous flow of uniform, sound castings necessary to the automotive industry must be maintained with no sacrifice in quality. That's why more Fine FANNER motor chaplets have been used by more producers of automotive castings than all other types combined.

Fine FANNER motor chaplets with their exclusive designs, their positive core support, accuracy of production and their complete fusion help produce better, sounder castings at lower cost.

Prevent costly product failures due to unsound castings by using fine FANNER motor chaplets for all your requirements.

Only a few of the wide range of motor chaplets made by FANNER are shown here — get acquainted with the complete line by writing today for your free copy of the FANNER Chaplet Catalog.



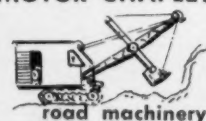
there are *fine* FANNER

pumps



furnaces

MOTOR CHAPLETS for many other products..



road machinery



locomotives



stoves



farm machinery

Circle No. 728, Page 7-8

ENGINEERING SERVICE

Qualified and specialized engineers in Fanner's Technical Service Division are available for consultation, without obligation, on problems of producing more intricate castings; developing increased strength, closer tolerances, and better quality; reducing machining and improving finish — both in ferrous and non-ferrous castings. Take advantage of the research and development work that Fanner has invested in this field to improve your profit picture! Simply direct your request to the address shown below.

THE FANNER MANUFACTURING COMPANY

designers and manufacturers of fine FANNER CHAPLETS AND CHILLS
BROOKSIDE PARK CLEVELAND 9, OHIO

control, replenishing molten metal, and castings removal. Production rates exceeding 1500 shots per hour claimed by manufacturer. *British Industries Corp.*

For Manufacturer's Information
Circle No. 610, Page 7-8

PUSHER ATTACHMENT . . . for use with manufacturer's 2000 and 3000-lb capacity fork lift trucks. Provides for mechanical unloading of



castings or packaged material directly from truck's forks. Useful in storage; eliminates need for tying up pallets for extended periods. *Elwell-Parker Electric Co.*

For Manufacturer's Information
Circle No. 611, Page 7-8

SPECTROMETER . . . shows ferrous and non-ferrous metals and alloys analysis within 30 sec.; gives instant direct reading of percentages of up to 30 alloying elements. Design permits optional film recording of analytical spectrum. Said not to require prolonged operator training, to have easily serviced plug-in components, and extreme temperature stability. *Jarrell-Ash Co.*

For Manufacturer's Information
Circle No. 612, Page 7-8

POWERED HOIST TROLLEY . . . lowers or moves loads up to 4000 lb when connected to beam hoist. Manufacturer claims operations performed with one-hand control, giving operator one hand free to guide load. Unit exerts 250-lb draw-bar pull on beam, pulls full load 70 ft per min, and has speed of from slow creep to 150 ft per min. *Gardner-Denver Co.*

For Manufacturer's Information
Circle No. 613, Page 7-8

SHELL MOLD . . . release agent eliminates sticking, break-in, build-up, and cleaning of shell mold patterns and core boxes. Applied by spray or brush, coating tested to withstand temperatures over 1000 F. Smokeless, non-toxic, and inert, this material also is said to be an effective high temperature lubricant. *Chem-Cote Co.*

For Manufacturer's Information
Circle No. 614, Page 7-8

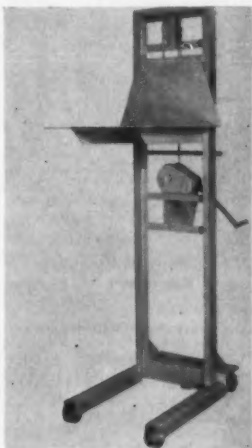
BLAST CLEANING . . . of castings and heat treated parts weighing up to 6 tons possible with 72-cu ft barrel. Loading, starting, stopping and

■ Details on these products and processes are available to MODERN CASTINGS readers. See page 7-8.

unloading operations automatically performed from control panel. Heavy apron work provided to handle large castings weighing over 2000 lb. Unit has 2 blast wheels, each capable of throwing 120,000 lb of abrasive per hr. Scale, dust, and broken-down abrasives are removed, after which the abrasive is returned to the machine for re-use. Pangborn Corp.

For Manufacturer's Information
Circle No. 615, Page 7-8

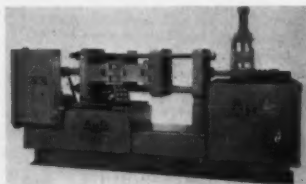
LOW-PRICED HANDLING . . . of foundry materials up to 1000 lb by mechanical lifter which is cranked



up or down. Platform, 24 sq in., lifts to 69 in. from floor level. Handle effort is 27 lb at full load. The Colson Corp.

For Manufacturer's Information
Circle No. 616, Page 7-8

DIE CASTING MACHINE . . . with capacity of 7-lb shot in zinc, 150-ton locking pressure, and 24x24-in. steel platens. Said to have extra large



capacity melting furnace and high cycling speed. Convertible to aluminum with cold chamber attachment. A B C Die Casting Machine Co.

For Manufacturer's Information
Circle No. 617, Page 7-8

SOLAR FURNACE . . . designed as new tool for scientific research. Ad-

Circle No. 729, Page 7-8



NATIONAL MOLDER'S HELPER

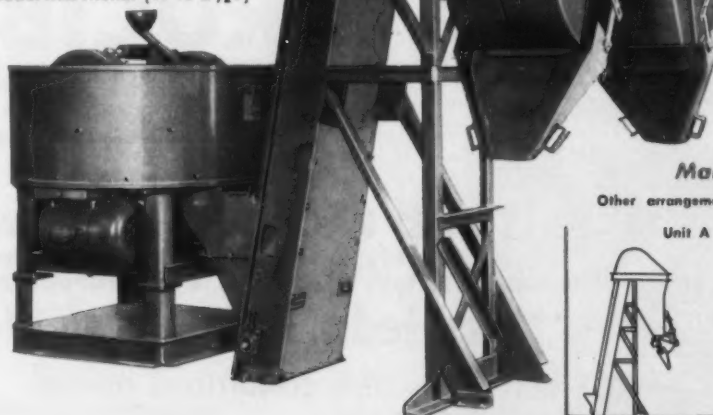


It's an "Elevayor"

This unique National-patented equipment item will deliver a full mixer batch from discharge door to bin within 20-30 seconds. Can be designed to receive charge from front end loader too. Shoveling or extra handling is completely eliminated.

Use it with any Mix-Muller

You've already cut your costs if you're now a Mix-Muller user! Molder's Helper can be used with any Model Mix-Muller (1F to 2 1/2 F)



Molder's Helper with 1 1/2 F Mix-Muller handles 1000 lb. batch. Is equipped with two 50 cu. ft. hoppers.

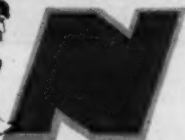
Now any foundry can afford to have overhead sand!

The National Molder's Helper is designed to eliminate the costly time and labor consuming job of hauling sand from mixer to molder. With it, you can bring overhead sand to the smallest operation; *increase* molders production up to 50%; *eliminate* floor shoveling and *concentrate* your entire mixing and molding operation into no more floor space than one molder now occupies.

Cold hard dollars saved in increased efficiency, lower labor costs and better, more flowable sand—can quickly pay the small cost of the Molder's Helper. *But what's more* any foundry with a Simpson Mix-Muller already has a head start in equipment. Write for further details today, or let your man from NATIONAL give you an estimate.



NATIONAL ENGINEERING COMPANY



630 Machinery Hall Bldg.
Chicago 6, Illinois

It's an aerator!

Upper section of "Elevayor" automatically aerates sand. Another step eliminated, another item of equipment and labor that's built-in with this low cost mechanized National "package" unit.

It's overhead sand

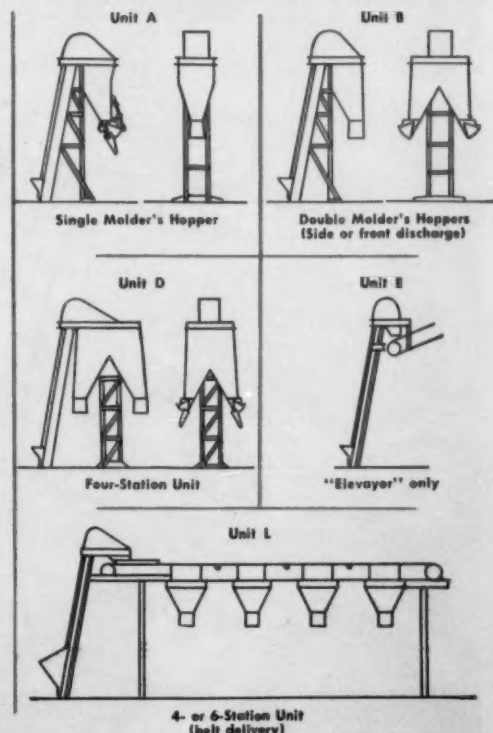
Sturdy, NATIONAL Molder's Hoppers receive fluffy, aerated free-flowing sand ready for molding—in seconds. Units available for 2, 4 or 6 molders stations. Riddling and shoveling are eliminated to cut molder's time up to 50%.

It's National Quality

The Molder's Helper is a foundry proven item. Its design, fabrication and performance characteristics reflect the same quality of workmanship that is found in all National-engineered components.

Many arrangements possible

Other arrangements available to suit specific requirements.



ANOTHER!
PROVEN PRODUCT OF THE
PRACTICAL FOUNDRYMAN
BY NATIONAL



A battery of gas fired, stationary Crucible furnaces at U. S. Naval Gun Factory, Washington, D. C. The pipes manifolded to each set of three furnaces supply air at one pound pressure. Proportional mixers assure constant gas-air ratio set for maximum fuel efficiency and proper furnace atmosphere.

*Speed
up
melting*

with

CRUCIBLE FURNACES

Metal Quality is best and costs are lowest
when **CRUCIBLE FURNACES** are
operated at maximum efficiency

THESE FIRMS CAN TAKE
CARE OF ALL YOUR
REQUIREMENTS FOR

**CRUCIBLE
MELTING**

Lava Crucible-Refractories Co.
American Refractories & Crucible Corp.
Electro Refractories & Abrasives Corp.
Ross-Tacony Crucible Co.
Vesuvius Crucible Co.
Joseph Dixon Crucible Co.

**BEST OPERATING CONDITIONS DEPEND
ESSENTIALLY ON —**

- ✓ 1. adequate fuel and air supply
- ✓ 2. proper fuel air ratio
- ✓ 3. furnace lining and covers in good condition

Have you seen the new "CRUCIBLE CHARLIE" says . . . leaflets issued by Crucible Manufacturers Association? If not, ask your superintendent about this. He has a copy.



CRUCIBLE MANUFACTURERS ASSOCIATION

11 W. 42nd Street, New York 36, New York

vantages said to be freedom from contamination, instantaneous attainment of very high temperatures, continuous visual monitoring of materials under test, and controlled atmosphere. Manufacturer claims fully mobile furnace locks on sun without external guidance. *American Searchlight Corp.*

For Manufacturer's Information
Circle No. 618, Page 7-8

LIFTING AND TILTING . . . of barrels, boxes and containers achieved with device designed for attachment to fork trucks, cranes, or hoists. Said



to lift and pour loaded barrels with ease. Has safe, positive grip, 1000-lb capacity—one man operation. *Pu-cel Enterprises Inc.*

For Manufacturer's Information
Circle No. 619, Page 7-8

ULTRASONIC TESTING . . . thickness of sound conductive material measured by touching instrument to surface. Used to determine eccentricity in cored castings, pipe, etc. Battery powered unit, has ± 2 per cent accuracy. *Magnaflux Corp.*

Circle No. 652, Page 7-8

PORTABLE NIBBLER . . . said to permit cutting of ferrous and non-ferrous metals without distortion. Capable of cutting up to 10 gauge stainless steel, across contours and over curves. Models also available for medium and lightweight cutting. *Fen-way Machine Co.*

For Manufacturer's Information
Circle No. 620, Page 7-8

WEAR RESISTANT . . . metal coating said to add 150 per cent more wear to metal components. New alloy applied with metallizing type gun for hot spraying, followed by heat treatment with oxyacetylene torch for final fusion. Sprayed on to 1/16-in. thick, fuses at 1300-1400 F. *Walmet Corp.*

For Manufacturer's Information
Circle No. 621, Page 7-8

DOCK BOARDS . . . of magnesium claimed to solve practically any loading problem. Curbs tapered to prevent wheel rims from coming into contact; eliminates possibility of jagged edges which cut tires. Manufac-

■ Details on these products and processes are available to MODERN CASTINGS readers. See page 7-8.

turer claims features which assure smooth crossover; no dock board slip-page; safe, secure locking action; and easy positioning. *Magline Inc.*

For Manufacturer's Information
Circle No. 622, Page 7-8

HYDRAULIC YARD CRANE . . . eliminates use of conventional winch; cable operated by hydraulic ram in end of boom. Boom raises, swings, and telescopes by full hydraulic power.



Handles full rated load without topping boom, keeping boom close to load, and reducing load sway. Capacities 3-10 tons. *Groce Mfg. Co.*

For Manufacturer's Information
Circle No. 623, Page 7-8

PORTABLE DRAFTING MACHINE . . . can be folded jackknife-style to fit in pocket. Made of aluminum, is said to take the place of T-square, ruler, protractor, and triangles when attached to portable drawing board. *David Miller & Associates.*

For Manufacturer's Information
Circle No. 624, Page 7-8

PORTABLE DRUM RACKS . . . of heavy gage steel, each unit capable of supporting two loaded steel drums up to 14,000 lb. Stacking with fork-lift trucks to any practical height permitted, each pair of drums resting horizontally on pair below. Two-drum or single drum lift possible from front, back, or either side, using fork lift truck. The unit weighs 35½ lb. *Republic Steel.*

For Manufacturer's Information
Circle No. 625, Page 7-8

INDUSTRIAL TRUCK TIRES . . . of synthetic material said to outlast other synthetic and rubber tires 4-10 times. Manufacturer claims wheel-tire combination as strong as steel, but more resilient than rubber, avoiding damage to floors. Non-pneumatic, cannot develop flats; 4x3-in. wheel is rated to 2000 lb. *Madden Tire Co.*

For Manufacturer's Information
Circle No. 626, Page 7-8

FASTER INTERNAL COMMUNICATIONS . . . through combination of privately owned inter-plant telephone system with paging or sound system. If called party does not answer, a lever in telephone handset permits

At Campbell, Wyant and Cannon—

Quality Control of camshafts starts with

HANNA PIG IRON

Campbell, Wyant and Cannon Foundry Company, division of Textron, Inc., has long been one of the world's leading suppliers of automotive castings. And throughout their many years of pioneering in metallurgy and foundry practice, Campbell, Wyant and Cannon has been a regular user of Hanna pig iron—both standard and silvery.

Typical of C.W.C.'s precision production in volume at their Muskegon, Michigan, foundry are cast camshafts, which were first introduced by C.W.C. to the automotive industry 25 years ago and are now used throughout the world.

Customers' specifications for these camshafts are extremely precise. Dimension, composition, including chemistry and metallurgical structure, hardness—all are vitally important.

In one of the many testing procedures employed to assure that casting quality is up to specifications, C.W.C. through the use of a direct reading spectrometer determines approximately every 20 minutes the analysis of samples taken from electric furnaces and ladles. The commercial application of spectrographic analysis of metals in the foundry was first worked out by C.W.C. in conjunction with the University of Michigan. Only metal made with pig iron of accurate analysis and superior uniformity, like Hanna pig iron, can pass this exacting quality control check.

Hanna produces all regular grades of pig iron as well as HannaTite and Hanna Silvery. All grades are available in the 38-lb. pig and the smaller HannaTen 12½-lb. ingot. Your Hanna representative will be pleased to tell you more about the advantages of using Hanna pig iron.



At 20-minute intervals, C.W.C. checks metal analyses with a direct reading spectrometer.

THE HANNA FURNACE CORPORATION

Buffalo • Detroit • New York • Philadelphia
Merchant Pig Iron Division of

NATIONAL STEEL CORPORATION



A few of the 50 million camshafts produced by Campbell, Wyant and Cannon Foundry Company.



Circle No. 731, Page 7-8

PAYLOADER®

5 YEAR
USER

**"Definitely the key machine
in clean-up operations"**

Dewey Bros., Inc. at Goldsboro has been in business for 73 years and is the second largest foundry in North Carolina. It now uses two model HA "PAYLOADER" tractor-shovels and a larger model HAH to handle about 275 Tons of sand three times daily.

John H. Daniels, Dewey Bros.' equipment superintendent, referring to this model HAH "PAYLOADER" says, "it has been the most trouble-free machine ever used on the job . . . has had less than 35 hours lost time in nearly 3 years of continuous service. I want to say also that the "PAYLOADER" Distributor offers the best service of any of our suppliers."

Edgar Knowles, asst. night foreman, also adds, "Our HAH is definitely the key machine in the clean-up operation. It is fast, maneuverable and dependable. The roll-back bucket carries a heaped load without spillage."

Whatever size or sizes of tractor-shovels you need in your operations, you can be sure, like Dewey Bros., Inc. of getting top production and dependable performance if you choose a proven "PAYLOADER", plus unmatched service from the Hough Distributor that sells them. It will pay to have him show you what a "PAYLOADER" can do. Ask him about Hough Purchase and Lease Plans too.

THE FRANK G. HOUGH CO.

711 Sunnyside Ave., Libertyville, Ill.

Please send "PAYLOADER" information:

- ☐ Model HA (2,000 lbs. carry cap.)
- ☐ Model HAH (3,000 lbs. carry cap.)
- ☐ Attachments for scrap handling

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Title _____

Company _____

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City _____ State _____

4-A-2



Modern Materials Handling Equipment

THE FRANK G. HOUGH CO.

LIBERTYVILLE, ILLINOIS
SUBSIDIARY—INTERNATIONAL HARVESTER COMPANY



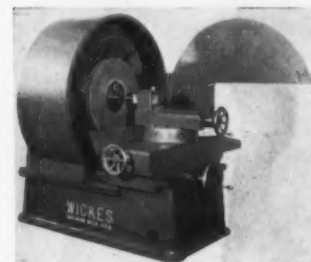
caller to broadcast his voice over loud speakers. When phone is answered, paging system is disconnected, allowing private conversation. *Private Telecommunications, Inc.*

For Manufacturer's Information
Circle No. 627, Page 7-8

MINIATURE RECORDER . . . lightweight, self powered, portable, for recording conferences, lectures, meetings, dictation, etc. Said to record up to 60 ft away for periods up to 4 hr. Manufacturer claims recording starts automatically as voice speaks, and stops within 8 sec after voice ceases, eliminating recording of silent periods. *Miles Reproducer Co.*

For Manufacturer's Information
Circle No. 628, Page 7-8

GRINDING WHEEL SALVAGING . . . for further productive use possible with machine which resizes worn grinding wheels. Said to re-establish wheel's bore in 15-20 min; handles



8 to 42-in. diameter wheels up to 14 in. thick. Includes ducting for connecting into plant dust collecting systems. *Wickes Corp.*

For Manufacturer's Information
Circle No. 629, Page 7-8

LIGHTWEIGHT INSPECTION . . . equipment for use in pattern shops adds new ease of handling and accuracy to tool, die and pattern making. Right angle plates, tooling angles, height blocks, etc. of magnesium and aluminum are 1/4 the weight of steel units. Working surfaces scraped to special order accuracies, standard accuracy for height blocks is 0.0001 in. *Challenge Machinery Co.*

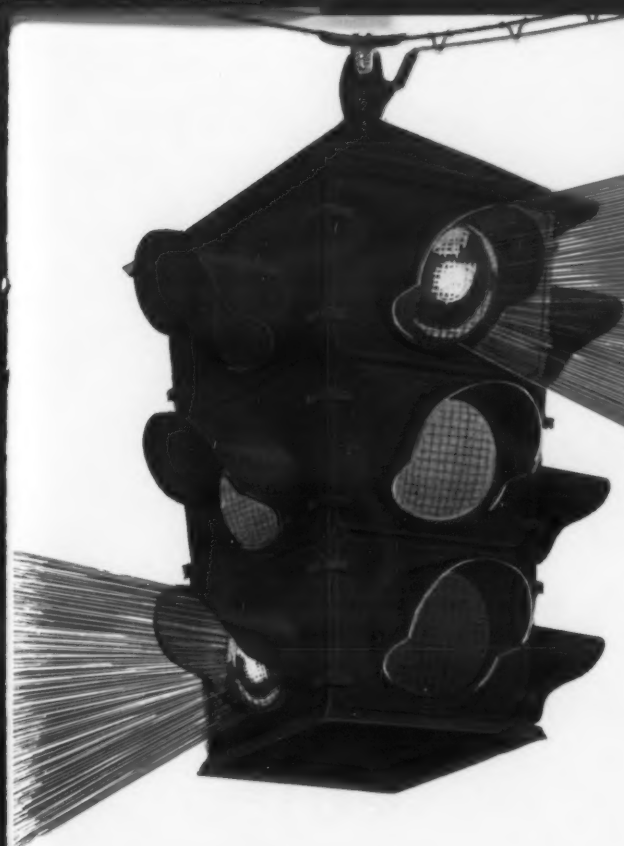
For Manufacturer's Information
Circle No. 630, Page 7-8

SMALL ALUMINUM PIGS . . . 10 and 30 lb, available in 2312, A2312, 2393, and 2364 alloys. Useful in foundries with limited equipment that find it difficult to handle standard 50 lb size pigs. *Kaiser Aluminum Chemical Sales, Inc.*

For Manufacturer's Information
Circle No. 631, Page 7-8

WEAR RESISTANT STEEL . . . parts, available in cast form for spe-

Circle No. 732, Page 7-8



ELIMINATE ACCIDENTS

USE COLOR-CODED BRIQUETS

Briquets are the most convenient method of adding alloys to the cupola charge—additions are made by count and weighing is eliminated.

Like other briquets, all Ohio Ferro-Alloys briquets contain an exact weight of alloy. But, only the unique OFAC system of Color Coded Briquets can offer you positive identification of the different elements. Like the stoplight, it's the time-tested system of control.

Write for Your FREE Copy of our brochure —
"BRIQUETS IN THE IRON FOUNDRY"



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SILICO-MANGANESE
BRIQUETS**



**GREEN
CHROMIUM
BRIQUETS**

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MANGANESE
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Canton, Ohio*

KNIGHT ENGINEERING EXPERIENCE CAN HELP

strengthen your profit position

The Knight organization with experience based on more than 400 successfully completed assignments in the foundry field has repeatedly assisted management to:

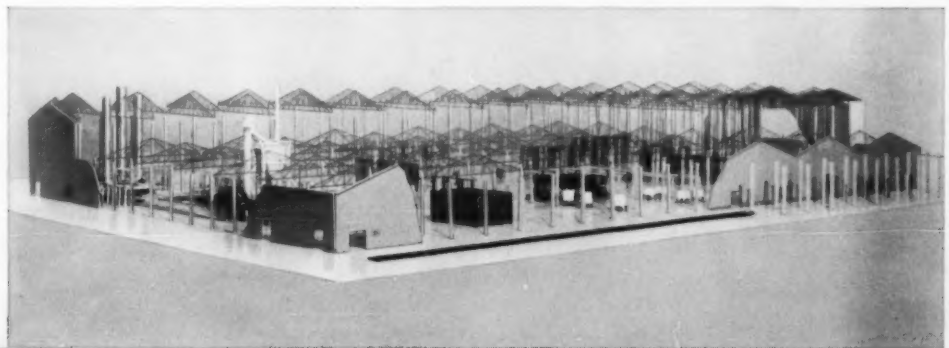
- MAINTAIN OR IMPROVE PROFITABILITY IN THE HIGHLY COMPETITIVE FOUNDRY INDUSTRY.
- MEET THE DEMAND FOR IMPROVED QUALITY AND PERFORMANCE OF CASTINGS
- DEVELOP AND CARRY OUT PROGRAMS TO APPLY MOTORIZATION, MECHANIZATION, AUTOMATION, AND THE MOST MODERN TECHNIQUES AND EQUIPMENT WHERE APPLICABLE.
- DETERMINE WHAT MUST BE DONE TO INSURE FULL UTILIZATION OF MAN HOURS AND MACHINE CAPACITIES.

It may be that you are paying for the modernization of your foundry without getting the benefit of more modern methods. Call or write Knight, without obligation, if you have a problem to discuss.

**Knight
services
include:**

Foundry Engineering
Architectural Engineering
Construction Management
Organization
Management
Industrial Engineering
Wage Incentives
Cost Control
Standard Costs
Flexible Budgeting
Production Control
Modernization
Mechanization
Methods
Materials Handling
Automation
Survey of Facilities
Marketing

See this scale model of the newest and largest cylinder block, chilled iron wheel, agricultural implement, fittings and ingot molds and rolls foundry in Argentina at the Castings Convention and Foundry Show—Booth 2034.



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Knight Engineering Establishment (Vaduz), Zurich Branch, Bahnhofstrasse 17, Zurich, Switzerland

■ Details on these products and processes are available to MODERN CASTINGS readers. See page 7-8.

cial applications in foundries. Parts are said to be of the most wear resistant steel known; tests indicate 4-10 times longer life than standard parts. *Latrobe Steel Co.*

For Manufacturer's Information
Circle No. 632, Page 7-8

OSCILLATING CONVEYOR . . . said to provide continuous forwarding of materials regardless of overloads or surges. Divider plates can be installed to convey more than one material at a time; discharge possible



at any point. Aluminum coils said to provide constant rate of vibration utilizing drive reserve to assure operation under surge conditions. Available in 5-10 ft assembled sections, 10-20 in. widths. *Link-Belt Co.*

For Manufacturer's Information
Circle No. 633, Page 7-8

MARKING NAILS . . . made to order for distinguishing company products and a variety of foundry applications such as marking patterns. Markings



either raised or depressed, heads available with outer rim to protect markings when nail is driven. Non-corrosive copper or aluminum. *John Hassall, Inc.*

For Manufacturer's Information
Circle No. 634, Page 7-8

PORTABLE SHED . . . of "build-it-yourself" aluminum said to save up to 90 per cent in time, money, and effort. Units are prefabricated to specifications and come with screws and bolts ready for assembling; 10x20 ft shed said to weigh 150 lb, and to be easily moved and erected. *J. B. Sebrell Corp.*

For Manufacturer's Information
Circle No. 635, Page 7-8

PORTABLE AIR HEATER . . . said to provide safe, clean, efficient heat where and when needed. Manufac-

This is it... THE NEW MIRACLE LIQUID PARTING DELTA PART-RITE

FOR PERFECT MOLDS AND CORES



Working samples and complete literature on Delta Part-Rite will be sent to you on request for test purposes in your own foundry.

DELTA

- Sand flows and packs freely to give perfect reproductions of pattern details.
- Patterns and core boxes stay cleaner longer with one application.
- No sand sticking.
- Use at any temperature.
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- Use sparingly — a micro-film is all that's necessary on patterns and core boxes.
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MANUFACTURERS OF SCIENTIFICALLY CONTROLLED FOUNDRY PRODUCTS

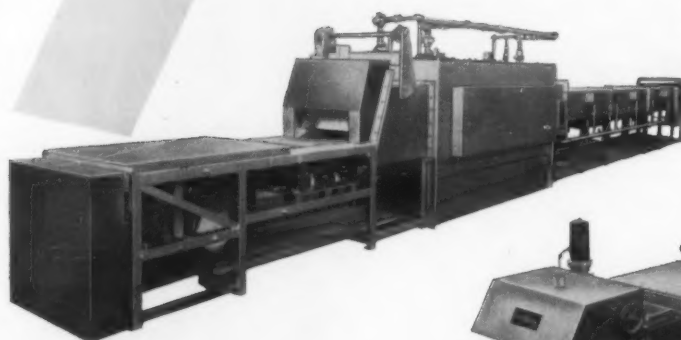
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Look to Lindberg for sintering furnaces



Hand Pusher Batch Type Furnace

For small production lots and experimental sintering. An all-purpose unit for operation from 1300°F. to 2500°F. Made in various sizes for sintering from 25 to 300 pounds per hour.

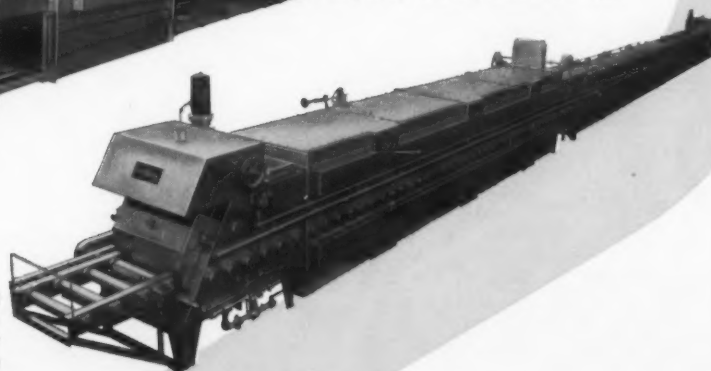


Mesh Belt Continuous Type Furnace

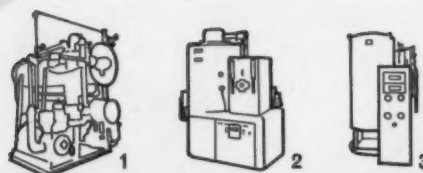
Sintering furnace for small light parts in copper, bronze, brass or steel. Temperature range from 1300°F. to 2100°F. Provides low temperature silver brazing, bright annealing, as well as sintering of powder metals. Production ranges up to 500 pounds per hour.

Roller Hearth Continuous Type Furnace

Designed to handle loads up to 2200 pounds per hour. Effective temperature range from 1300°F. to 2100°F. For bright annealing, low temperature silver brazing as well as sintering of powder metals.



For sintering furnaces, just as in all types of industrial heating equipment, you can depend on Lindberg's ability to supply exactly the right equipment for your needs. Just get in touch with your nearest Lindberg Field Representative, or write Lindberg Engineering Company, 2440 West Hubbard Street, Chicago 12, Illinois. Los Angeles Plant: 11937 South Regentview Avenue, at Downey, California.



Lindberg atmosphere generators provide the proper atmospheres recommended for use with Lindberg Sintering Furnaces. These are: 1. HYEX Generator...approximately 4% carbon dioxide—18% hydrogen—12% carbon monoxide and 66% nitrogen. 2. HYEN Generator... neutral atmosphere approximately 21% carbon monoxide—40% hydrogen—38% nitrogen and 1% methane. 3. HYAM Generator... composed of approximately 75% hydrogen and 25% nitrogen.

See Lindberg in Booth No. 12, Metal Powder Show in Philadelphia

LINDBERG

heat for industry

turer claims fumes, smoke, and carbon monoxide vented outside; fire risk eliminated; and only uncontaminated air enters working area. *American Air Filter Co.*

For Manufacturer's Information
Circle No. 636, Page 7-8

PRE-HEATED CUPOLA AIR . . . with fired heaters said to make initial melt faster and give hotter iron while cutting cupola coke consumption 20-30 per cent. Furnished with burners and all necessary controls. Delivers air at 1000 F in 2-3 min. *Brown Fintube Co.*

For Manufacturer's Information
Circle No. 637, Page 7-8

DIELECTRIC CORE OVEN . . . serves up to 7 core blowing machines with total time in the oven said to be approximately 12 min. The oven has a nominal output rating of 200 kw, and bakes up to 10,000 lb of phenol-resin bonded cores per hr. Available



in standard models with 30-200 kw power output capacity; the ovens, according to the manufacturer, do not require a full time operator. *Foundry Equipment Co.*

For Manufacturer's Information
Circle No. 638, Page 7-8

WIRE ROPE SLINGS . . . using patented lock provide strong, safe lifting means for heavy foundry loads. Because sling and lock weigh less than chains, according to manufacturer's data, existing hoist or crane can lift greater load. Castings may be stored strapped and locked in sling, eliminating pallets. *Cam A Loc Co.*

For Manufacturer's Information
Circle No. 639, Page 7-8

SHELL RESIN POWDER . . . said to be superior in regard to odor, mold release, and rigidity. *Borden Chemical Co.*

For Manufacturer's Information
Circle No. 640, Page 7-8

FLEXIBLE CONVEYOR-LOADER . . . combines moving and loading or stacking of castings, patterns, etc. in one portable unit which bends to U-shape, S-shape, or may be operated in a straight line. Self-contained power unit for both operation and moving of conveyor. One-man operation by means of push-buttons on the stacking unit. *Jervis B. Webb Co.*

For Manufacturer's Information
Circle No. 641, Page 7-8

Ear Protection Needed for Those in Excess Noise Area

■ No matter what the extent, if any, of environmental control aimed at reducing noise in the foundry, exposure to excessive noise is a problem; for it may produce a permanent hearing loss unless protective measures are taken. In foundry operations involving excessive noise, ear protectors must be used to reduce the noise levels at the inner ear.

Two types of ear protectors are available for foundry use, ear plugs and ear muffs. Plugs, designed to close the ear canal, are made in two forms; substances molded by the user, and ready-made plugs.

Cotton Unaffactive

Plugs molded by the user to fit his ear are commonly made of fiber impregnated with wax, and can be discarded after use, other types are reusable. Contrary to the average worker's feelings, dry cotton affords very little, if any, protection.

Ready-made plugs have usually been shaped from natural rubber, neoprene, or plastic. They are ordinarily manufactured in small, medium, and large sizes, and fit into the ear canal.

Ear muffs, made of soft, spongy material, are designed to cover the entire external ear; the muffs are held in place by adjustable headbands or special caps.

Care must be taken to select ear protectors specifically designed for protection against noise. Make-shift devices, such as pencil erasers, empty bullet cartridges, or dry cotton should never be used.

Protection Varies

Lubricated ear plugs afford a better seal and therefore greater protection. For frequencies above 1000 cps, ear muffs provide about the same protection as ear plugs. Below this figure, muffs provide less protection than plugs. A survey should be made of the noise problems encountered in the plant, and careful consideration given to the types of protection available before adopting either ear plugs or muffs.

Voice communication and the hearing of warning signals is not impaired by wearing ear protectors. Workers, who regularly wear ear protection, report that they actually hear better in noisy areas. Cutting down the noise level reaching the ear decreases the distortion in the ear so that speech and warning signals are heard more clearly, much as sun glasses reduce excess glare and thus improve vision.

HILL-ACME

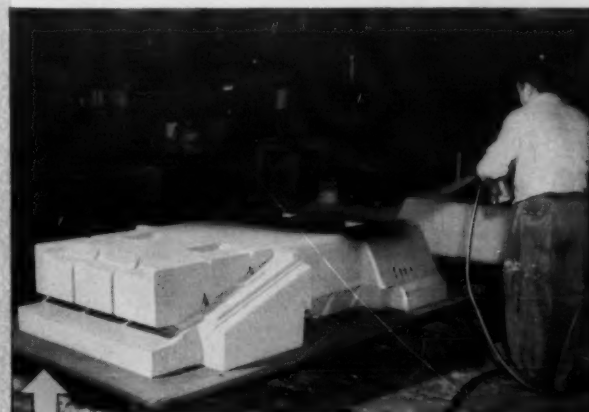
reports on value of...



John Makren and Joe Zargel, coremakers at Hill-Acme are stripping the box from a 3000-lb. LIN-O-SET core which is typical of much of the core work in this modern foundry. Two of these giants form the core assembly for a 3½-ton machine tool base pan casting. Note the delicate undercut on the left side of the core, which involved considerable time and trouble prior to the use of LIN-O-SET.



Otto Spirek, plant superintendent at Hill-Acme, discusses mixing procedures with Dan Chester, ADM Technical Service Mgr., who makes periodic checks on procedures, and stands ready to apply his specialized knowledge to core problems as they arise.



Hill-Acme castings are known for their excellent finish. They attribute this to high density of LIN-O-SET cores, and the use of FEDERAL No. 801 PLUMBAGO COREWASH. Illustration shows Paul Colella spraying on FEDERAL No. 801.

LIN-O-SET

½ the fabricating time
½ the baking time

...and vastly improved casting finish. These are the primary reasons why HILL-ACME COMPANY of Cleveland, Ohio, switched from conventional core oil to LIN-O-SET.

Larry Rayel, ADM Representative, suggested that Hill-Acme try LIN-O-SET as an experiment. The huge, complicated cores presented constant problems: for instance, they had to use back-up sand to reinforce delicate undercuts; it was difficult to hold dimensional stability and at the same time attain sufficient flowability for easy ramming; they had to "baby" green cores due to their extreme size and weight; then the large cores had to bake for two nights.

After a demonstration by ADM Technical Service Manager, Dan Chester, it was decided to put LIN-O-SET into the entire core operation.

Now, a year later, these are the recognized benefits: after a short air-curing period, core boxes are stripped faster and easier without danger to the core, and the core has absolutely no sag after stripping; there is less need for rodding; high green strength of the cores as drawn permits safer handling, reducing green core breakage; minimum ramming and tucking are required due to low green strength and high flowability of LIN-O-SET sand as discharged from the muller. All in all, total fabrication time for LIN-O-SET cores is estimated to be at least 50% less.

Baking time was reduced from two nights to one night. Excellent collapsibility of the cores reduces cleaning to a minimum.

Perhaps a demonstration of LIN-O-SET in your foundry will bring about attractive savings for you. Write for LIN-O-SET technical bulletin.



Archer Daniels-Midland company

FEDERAL FOUNDRY SUPPLY DIVISION

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Aim toward better castings through the use of Archer Quality Supplies:

GREEN BOND H-J High-gelatinating Bentonite	FEDERAL Sand Stabilizer	LINOIL Core Oils	ADMIREZ Foundry Resins
GREEN BOND L-J Low-gelatinating Bentonite	FEDERAL Core Washes	INDUCTOL Fast-baking Core Oils	ADCOSIL CO ₂ Binders
CROWN HILL Sea Coal	FEDERAL Plumbagos	LIN-O-SET Air-setting Core Binders	LIN-O-CEL Sand Stabilizer
	FEDERAL Core Pastes		FRE-FLO Parting Compound

New Induction Furnace for Alloys, Castings Research

■ Research aimed at improved alloys and high quality castings has been augmented at the Battelle Memorial Institute, Columbus, Ohio, with a new production-size vacuum induction furnace for the metallurgical laboratory. The new unit is capable of



melting from 10 to 300 lb of metal at one time. The 5x8 ft vacuum chamber is cooled by a water jacket over the upper one-third of the shell, the remainder of which is cooled with copper coils. The furnace can be adapted to maintain a vacuum even during repeated bulk charging or alloy additions required in continuous operation. Vacuum and electrical controls allow for one-man operation from a central location.

New Melting Technique Uses Electron Gun

■ High vacuum techniques are now being used to melt and cast special metals, such as titanium, zirconium, molybdenum, and columbium, on a semi-works scale. The new process is owned jointly by Stauffer Chemical Co., New York; Mallory-Sharon Titanium Corp., Niles, Ohio; and Temescal Metallurgical Corp., Richmond, Calif.; the companies that cooperated in its development.

The process uses electron bombardment in a high vacuum to melt chemically-active materials which have high melting points; it is said to make available for the first time commercial quantities of high purity material at substantially lower costs.

Heat for melting is supplied by an electron gun which serves as the cathode and bombards the melt stock with electrons, heating it to the melting point. Molten metal drops into a water-cooled copper crucible in which the heat required to maintain a molten pool is also provided by electron bombardment.

Advantages of electron beam melting over vacuum arc melting are claimed to be: electron beam can be started and stopped at any time

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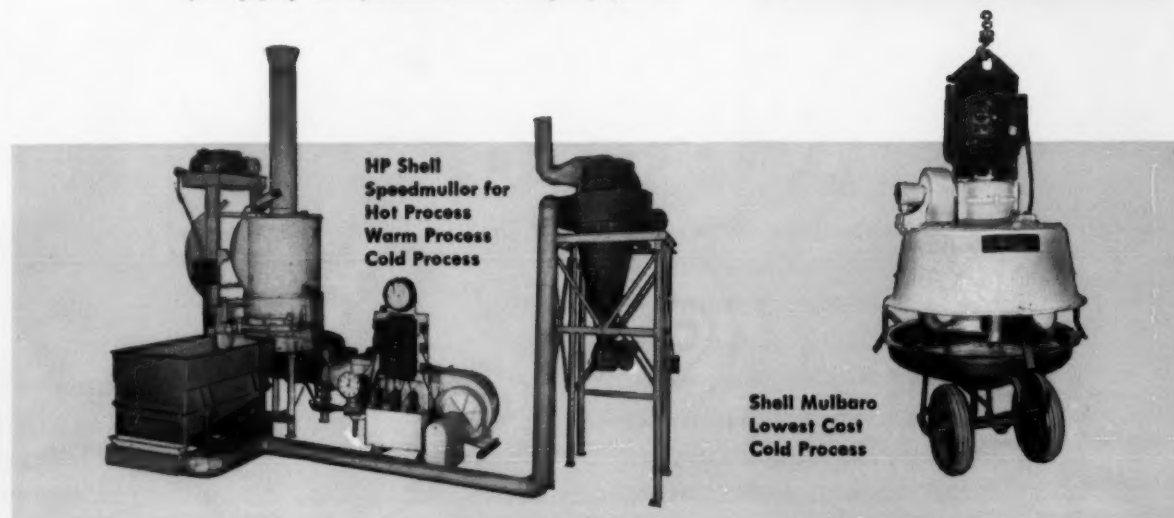
Weigh the cost of coating equipment against the savings it will effect in reduced resin requirements, higher production, improved quality, and storage and handling advantages. You will find the savings will quickly pay for Speedmullor coating equipment.

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COATED SANDS
CUTS RESIN COSTS
UP TO 50%**

**SPEEDMULLOR
COATED SANDS
IMPROVE
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**SPEEDMULLOR
COATED SANDS
DO NOT
DETERIORATE**

**SPEEDMULLOR
COATED SANDS
END DUST
HAZARD**



There is no segregation of resin with Speedmullor-coated sand . . . perfect bond is obtained with a minimum of resin. The microscopic layer surrounding the coated grain effects a superior bond with far less resin. CAN YOU AFFORD to use up to twice as much resin and still not obtain maximum physical properties in an uncoated mixture?

Speedmullor-coated sands produce stronger, more uniform shells with no gas-forming, segregated resin pockets. The resin is all in a perfect film around the sand grains. Properly coated sands provide excellent flowability and moldability, further enhancing quality. CAN YOU AFFORD casting losses because of arching, voids, porosity and blows or gas holes caused by resin segregation in an uncoated mixture?

Speedmullor-coated sands are processed for stability. The physical properties of the coated sand remain unchanged indefinitely under normal storage conditions. CAN YOU AFFORD costly losses when uncoated sands must be discarded because of deterioration in storage? CAN YOU AFFORD the poor casting quality caused when partially deteriorated uncoated sands are used?

Speedmullor coating eliminates the hazards and drawbacks of dry resin sand mixtures. CAN YOU AFFORD to risk the severe dust and explosion hazard, and air contamination because of the very fine resins used in uncoated sand mixtures? CAN YOU AFFORD the expense of using only part of the resin for bonding, losing the rest through the exhaust system?

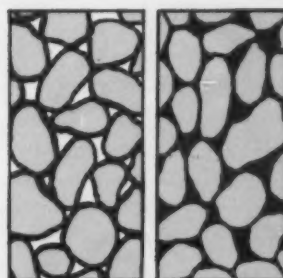
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Use the reader service card inserted in this publication to obtain additional information.



Left: A microscopic film of resin surrounds each grain of sand in a Speedmullor-coated mixture, effecting a superior bond.

Right: Up to twice as much resin is required to effect a bond in a dry resin sand mixture, and maximum physical properties can't be developed.

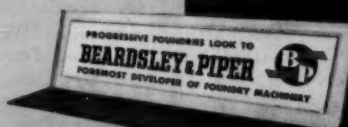
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SPEEDMULLOR**

**FIRST FOR
COATED SANDS**

**FIRST FOR
HOT PROCESS**

**FIRST FOR
COLD PROCESS**

**FIRST FOR
WARM PROCESS**



whereas if vacuum arc melting is stopped, a valuable ingot is often lost; and, electron melting is accomplished in any form, ingot, powder, flake, or sponge, while the arc process requires compacted material.

■ For additional information about this new process, circle No. C, Reader Service Card, p. 7-8.

Czechs Experiment with Cupola Oxygen-air Blast

■ Czech foundry specialists have completed a series of experiments introducing oxygen-enriched air blast into a cold blast cupola to determine how the tapping temperature of the iron can be most effectively increased with the least possible oxygen enrichment. Results are said to confirm Russian experiments which concluded that injection of oxygen at the rate of one per cent of the volume of blast raises the temperature of the iron 22½ to 27 F (12.5-15 C).

Oxygen was introduced at 44 to 73-1/2 psi into the cupola in three ways; through the tuyeres, through auxiliary tuyeres installed for the purpose, and through the blast pipe. After approximately 20 min injection through the tuyeres, the tapping temperature of the iron had risen to 2640 F, (1450 C), confirming the conclusion reached in Russian tests.

By injecting oxygen through auxiliary tuyeres, the iron actually became cooler instead of hotter. Oxygen losses were least in the last method, that of oxygen injection into the blast main at the point where it diverges from the blast belt.

An effect of oxygen enrichment in the blast was detectable only when the enrichment was two per cent or above. No effect on the quality of iron melted during oxygen injection, or adverse effect on the cupola lining was observed.

■ Condensed from a translation by H. Bratcher, circle No. E, page 7-8 for a list of translations available.

Gray Iron Castings Clinic Will be Held in Cleveland

■ Cleveland will be the site of a Gray Iron Casting Clinic April 9-10 sponsored by Superior Foundry, Inc., of that city. The clinic, to be held at the Hotel Pick-Carter, is intended to aid purchasing, engineering, and manufacturing departments in their efforts to lower end-product costs. Among others, W. L. Seelbach, Superior Foundry, Inc.; J. F. Wallace, Case Institute, Cleveland; and S. C. Masari, American Foundrymen's Society, will speak.

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PROFIT-MAKING EFFICIENCY**

Produce more molds per day using NOMAD CONVEYORS. Each man hour is more productive because molds are no longer carried away by the molder. Instead, molds "roll away" on conveyors.

NOMAD SAVES VALUABLE FLOOR SPACE with Double Level Track. This "2 in 1" conveyor gives additional saving of manpower when equipped with a Mold Dump at the shakeout end and a Pallet Raiser at the molders' end.



The gravity type Mold Dump shown above is of simple design and sturdy construction. It features a fast dumping cycle and effortless operation. A wide variety of mold sizes can be handled.

IT'S LOW COST MODERNIZATION!

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Circle No. 740, Page 7-8

the editor's field report

by

Jack Schaum

■ Confidence in the future is being shown by at least one foundry visited recently. Their product is being turned out at full plant capacity and stock-piled in quantities best measured in units of acres. With such a healthy inventory on hand, this company will be in good position to meet the demands of customers who will soon be placing orders with the request that the castings be shipped yesterday.

■ Starting in January of this year the Central Foundry Division of GMC has been holding every two weeks a Casting Design Conference at the Saginaw Malleable Iron Plant. To date over 275 metalcasting men, designers, and purchasers of castings have participated in these conferences. Initiated by James H. Smith, general manager, Central Foundry Division, and carried out under the direction of Elmer Braun, works manager, Central Foundry Division, visitors have really had their eyes opened to the potentialities of cast products. Many of the guests are from competitive companies and foundries. GMC is deserving of high praise for setting this fine example of progressive attitude to the rest of the industry. Besides a very interesting technical program, the conferees are treated to a complete tour of the foundry and research laboratories.

■ With its own fleet of 50 trucks, Tyler Pipe & Foundry Co., Tyler, Texas, can better keep its customers happy with on-the-spot delivery of cast iron pipe. What's more, the trucks don't "dead-head" but usually manage to pick up a return load of scrap metal or some other foundry supply needed in the Tyler plant.

■ A 68,000-lb salt bath at American Foundry & Machine Co., Salt Lake City, is being used for isothermal quenching of alloy steel castings. As much as six tons of castings can be handled at one time in the system. The rapid heat transfer from salt bath to casting or vice versa is an advantage that may also lead to its use as a high-speed annealing technique in the malleable industry.

■ The German pressure ladle technique for adding magnesium to molten iron is currently receiving considerable attention in this country—particularly by ductile iron pipe manufacturers. Although magnesium recovery is excellent, the big drawback seems to be the undesirably long period required to effect the treatment.

■ Hot sand in the molding system is becoming more of a problem as foundries speed up the time cycle of molding, pouring, shakeout and return of the sand for reuse. As the temperature of the sand increases in the system, sticking to the patterns becomes a serious problem. Molds are torn when patterns are withdrawn; and automated systems using electronic moisture control devices go out of calibration when temperature rises. To avoid these troubles in their automated mechanized foundry in Switzerland, George Fischer Ltd. cools the system sand to a constant temperature during each recycling. Eberhard Mfg. Co. has solved the problem of sand sticking by heating metal patterns for a few seconds with infra-red heaters prior to the molding operation.

Start Planning Now for Your Foundry of Tomorrow

by JOHN F. BERTUCCIO
J. C. Corrigan Co., Boston

■ Every foundry should be developing a long range master plan for modernizing its operations. These plans should include the ultimate in mechanization, bulk material handling, and automation. Creation of such a plan does not mean it must be acted on immediately. The plan is available as a guide in selecting the first piece of purchased equipment and determining its proper installation in the area indicated.

Any material handling or conveyor company will donate their services to help develop such an overall master plan. It does not cost any money to discuss these details with qualified people. But it will save a lot of money in the future if you start now to select the proper equipment to satisfy the future requirements of your operation and see to it that it is integrated into a carefully planned layout.

With such plans in outline form it is possible for you to make a partial investment each year—one piece of equipment at a time.

Step by step your foundry will grow into a fully mechanized unit that reflects long range planning. As each unit is added you can still modify the master plan to accommodate new ideas.

The Pay-Off

We are firm believers that foundry equipment, if efficiently planned, will pay for itself—often in 2 to 4 years. Bulk material handling not only saves labor costs but solves the problem of where to get more floor working area without constructing more buildings or buying more land. Mechanized handling permits overhead storage and movement of materials, thereby freeing much needed floor area for production.

A side benefit, but nevertheless a most important one, is the contribution of mechanized conveying toward "making the foundry a better place." Higher caliber men are needed in the industry and must be attracted by modern methods and equipment.

Automation, mechanization, and bulk material handling are words that should not disturb foundrymen or cause them any apprehension. Instead these words will help you produce more work, at a better return, in an environment that will attract better employees.

■ Condensed from a talk presented at New England Regional Foundry Conference.

PROBLEMS WITH FERRO-ALLOYS ?

CHEMICALS OF MOLYBDENUM...TUNGSTEN...BORON

Molybdenum is now available in unrestricted supply to improve strength and machinability. Dependable results are still one of its major attributes.

Tungsten, for hardenability and wearability improvement is now used in surprisingly small additions, with great success.

Boron, as an intensifier of the effects of other alloying materials, may be used in very minute additions, and yet maintain the essential properties of the castings desired. The most economical

and satisfactory form to introduce Boron is recognized to be found in MCA's Ferro-Boron.

Operating the world's largest rare earth deposits, the Molybdenum Corporation of America has recently conducted extensive pioneering research in evaluating the properties, applications and uses of RareMeT Compound.

In nodular iron, small additions of rare earths have helped to produce consistently good ductility by counteracting subversive elements such as lead and titanium.

Write today for further information.

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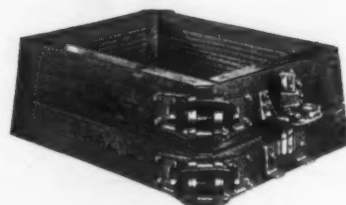


Circle No. 741, Page 7-8

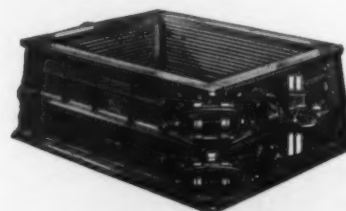
April 1958 • 23

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Above is the Adams jacket available in either cast iron or cast aluminum. They are cast from a top grade metal mixture best suited for their purpose. The sturdy construction as a result of the vertical ribs inside and horizontal ribs outside plus the handles at either end assure you of long life for this equipment and ease in handling. These jackets afford you MAXI-

MUM STRENGTH with MINIMUM WEIGHT.

Here are jackets that assure you perfect mold fit—will give you the greatest strength while under pouring strain—allow for free flow of gases all because of INSIDE CORRUGATIONS. These VENTILATED jackets are first choice in foundries across the nation.

Look into the advantages cast iron or cast aluminum can offer you depending upon your foundry needs. We will be happy to make recommendations to fill your requirements.

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new periodicals

Silvester, A. W., "The Foundry Industry in Australia." *Institute of Brit. Foundrymen, Australia Branch*, v 8 (1957) *Australian foundry history since World War II supported by charts and graphs for forecasting the casting business down under.*

Anan'ia A. A. and B. P. Chernobrovkin. "Cupola with Continuous-Slit Tuyeres." *Foundry Trade Journal*, Jan. 30, 1958, p 129.

Report on a Russian tuyere system wherein blast is introduced through peripheral slits.

Burke, T. R., "Efficient Cupola Operation." *Foundry*, Jan., 1958, p 89-93.

Article reviews several interdependent conditions: linings, coke, chill tests, fluxes, tuyeres, desulfurization.

"Ceramic Slurry Molding Process." *Modern Patternmaking*, Jan.-Feb. 1958, p 6. Advantages of ceramic slurry over plastics, plaster, or sand; duplicates patterns with undercuts and tapers. Process licensed by British Industries Corp.

"When Designers and Foundrymen Work Together, Costs Go Down." *Precision Molding* Jan., 1958, p 54.

Shell cores solved a bad assembly problem of three parts as well as several machining operations.

Turk, F. L., "Controlling the CO₂ Process." *Foundry*, Jan., 1958, p 94-97.

Before using the CO₂ process, article suggests preliminary studies through tests for sand selection, scratch hardness of cores in gassing, core weights, and cost analysis.

Brotzen, F. R., et al. "Gray Iron Castings." *Product Engineering*, v 29 n 3, Jan. 20, 1958, p 52-57.

Tells of mechanical and thermal properties of the metal as well as other metallurgical analyses: elasticity, hardness, creep, fatigue, etc.

Murton, A. E. and S. L. Gertsman. "A Literature Review of Metal Penetration." *MODERN CASTINGS*, Jan., 1958, p 37.

Five investigations do not reveal final solution to the problem, but suggested good foundry practice tends toward finalizing mold and core protection.

"Open-sand Moulding for Apprentices." *Foundry Trade Journal*, Jan. 30, 1958, p 125.

First of a series for beginners in the Trade. Down-to-earth language used with the problems presented.

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Controlling temperature in five places:
1. Alloying; 2. Molten holding furnace;
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Future of Investment Castings in Air-
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specialist regarding future needs.

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Discusses problems such as: burnt-on
sand, review of causes, advances made
towards a solution.

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New York American Chemical Society
Monograph, 1957, 657 pp.
Information on composition, properties
and performance of both metallic and
organic coatings. Chapters on corrosion
coatings, and sprayed metal coatings;
special explanations of new phenom-
ena as "silver migration" and "metallic
whiskers", and other up-to-date metal-
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From a paper presented in Stockholm
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Bronze." *Foundry*, Jan., 1958, p 84-88.
Deals with causes due to melting prac-
tice, such as dissolved gases in melts,
particularly hydrogen.

"Magnesium Die Castings in TM-61 Mis-
siles." *Precision Metal Molding*, Feb.
1958, p 23.
Article includes detailed drawing of
Matador's spoiler blade. Functional re-
quirements are explained and why AM-
265-C Dow R was used. The blade
electronically controls the missile's
flight trajectory.

new books

**Progress in the Development and
Utilization of Additives in the Foundry
Industry . . J. A. Gitzen. 37 pp. 1957.**

Every important core sand additive
used in modern foundry technology
is discussed. In most cases the histori-
cal background is included so that
the reader acquires a greater depth
of understanding why certain mate-
rials were tried and proved success-
ful.

By avoiding inclusion of lengthy
technical data, the author is able to
provide an interesting, concise guide
to the selection of core binders appro-
priate to the individual foundry's
needs.

Core sand additives covered in the
book are: water, sea coal and hydro-

How planned test procedures improve foundry profits



Lightweight Magnetic Particle Y-5 YOKE KIT Provides Portable Inspection

Uniform quality castings are far more
important to foundry profits and customers
than perfection. For this reason, many
gray iron foundries have adopted the Y-5
Yoke Kit for magnetic particle inspection
at stages of "in-process" operations. The
Y-5 is easy-to-use, fast, light-weight,
portable and low cost! It reliably detects
handling cracks, hot tears and similar
defects open to the surface. The Y-5 is a
convenient and inexpensive means of
checking pilot runs for cracks, or for
inspecting local areas of castings after
cleaning, machining, etc.

COMPLETE KIT ONLY **\$195⁰⁰**
F.O.B. Chicago, Ill.

THE HALLMARK
OF QUALITY IN
NONDESTRUCTIVE
TEST SYSTEMS



Take Your Inspection Problems to the House of Answers . . .
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Circle No. 743, Page 7-8

To expand the market for castings, foundrymen gain
by impressing their customers with the importance of
better designs and realistic specifications. If this is
done at the outset, your own profit and your customer's
continuing satisfaction are assured.

Establish practical design standards

Determine, if possible, the true service requirements
and practical characteristics your customer needs.
Mutually establish a standard which satisfies the need
at a reasonable cost. A good design must be satisfactory
functionally, structurally and foundry-wise.

Good design insures trouble-free foundry practice,
profitable operation and customer satisfaction. Cast-
ings with even stress flow are more serviceable and
are easier to pour. Experimental stress analysis with
M Stresscoat brittle coatings lets you make design
changes without guesswork or wasted effort. Design
for service, easy casting and high profits.

Keep your finger on the pulse of production

M Magnaglo (M Zyglo for non-ferrous) is recom-
mended as a "finger on the pulse" means of determi-
ning the causes of any cracking in the foundry. Simple
tests immediately after shakeout or cleaning can
locate cracks when they first occur. This permits you
to take corrective action, no matter what the cause.
With sampling inspection you actually control the
quality of the entire run as it is being poured. You
do not waste time and profits in handling, heat
treating, finishing, or machining, intermittent lots of
cracked castings. It all adds up to better products for
the customers and higher profits for the foundry!

Write for details on how Magnaflux nondestructive testing
methods can be employed to increase the yield of usable
castings and foundry profits. No obligation, of course!

**How to make
complex steel castings
with clean surfaces
closer tolerances
well-defined contours...**



Finished cores made with DEXOCOR combine high tensile strength and scratch hardness with high resistance to cracking and distortion, yet shake out easily.

Big producers of steel castings are "performing miracles" with the revolutionary new binder—DEXOCOR.

They report that DEXOCOR substantially reduces mulling time, saves on bake time as much as 40%, assures clean interior surfaces that need far less machining.

DEXOCOR used with cereal binders aids moisture control, provides excellent flowability, quick, easy mixing, blowing, ramming—and a welcome reduction in core scrap. With high green strength,

baked strength, and scratch hardness this remarkable new binder combines ready collapsibility, helps produce superior castings to closer dimensional tolerances despite intricate coring.

Says one of the country's top producers of steel castings, "The benefits were so obvious we changed over completely to DEXOCOR, now use it exclusively in sand mixes."

An 8-page report on the use of DEXOCOR Binder in steel casting is yours for the asking. Ask also

about friendly help from our foundry specialists in the use of DEXOCOR for improved cores.



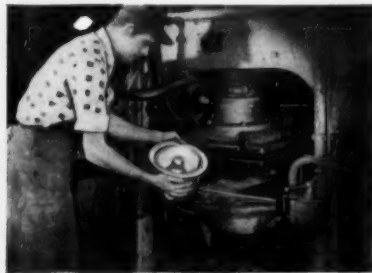
CORN PRODUCTS SALES COMPANY
17 Battery Place, New York 4, N. Y.

**DEXOCOR®
BINDER**

the perfect teammate for MOGUL® and
KORDEK® BINDERS • GLOBE® DEXTRINES



A water-soluble powder, DEXOCOR is convenient to handle, assures excellent flowability of sand mixes, contributes to uniform density of cores.



Uniform density throughout blown cores is assured by use of DEXOCOR. Sand mix fills recesses and corners as completely as other areas of box.



Increased thermal resistivity of cores made with DEXOCOR effectively curbs distortion and cracking, and also improves their collapsibility.

carbon substitutes, linseed oil and substitute oils, silica flour, polymerized resins, pitch, rosin, resin, corn flour, fire clay, western and southern bentonite, calcium lignin and lignin sulphate, iron oxide, wood flour, and plastic resins.

A selection of answers to pertinent questions asked by AFS members at meetings where the author lectured comprises the concluding chapter to the book.

Improvement of Sand Testing Techniques for shell Mold and Core Sands. PB 121412, Ofc. of Technical Services, U. S. Dept. of Commerce, July, 1956.

Standard sand tensile and transverse bend tests were evaluated to determine erratic behavior of sand specimens, warranting geometrical and other changes. Standard tensile briquettes vs. revised briquette with carying types of sand for baked cores and shells. Stress test inconsistencies attributed to the geometry of the different specimens.

Yearbook of the American Bureau of Metal Statistics, 1956 . . \$3.00, from the Bureau at 50 Broadway, New York 4, N. Y. Add 25¢ for overseas.

This statistical compilation contains data on the distribution of copper, lead, zinc, aluminum, gold, silver, tin, antimony, cadmium, cobalt, magnesium, molybdenum, nickel, platinum, and others. Plant capacities and metal prices are also included.

Notch Ductility of Commercial Malleable Irons . . H. F. Bishop, G. A. Sandoz, N. C. Howells, and W. S. Pellini. 25 pp. PB 111999. Office of Technical Services, Washington 25, D. C. 1956. Naval Research Laboratory NRL Report 4713. 75¢.

The effect of temperature on notch ductility was investigated for conditions entailing the presence of ultra-sharp notches. To establish the nil ductility transition temperature the drop-weight test was used, while the explosion crack-starter test established the relative level of resistance to fracture initiation and propagation at temperature above the nil ductility transition. Charpy V tests showed changes over the temperature range transition curve.

Chemical Engineering Practice, Vol. 3: Solid Systems (Part II) . . Herbert W. Cremer and Trefor Davies. 534 pp. Academic Press Inc., 111 Fifth Ave., New York 3, N. Y. 1957. \$17.50.

Vol. 3 of Chemical Engineering Practice is the second part of chemical engineering operations and processes involving solid systems. Vol. 3 covers size reduction, including all phases of crushing and grinding. Other sections describe screening, grading and classifying as well as handling and storage of solids. The edition concludes with the cleaning of gaseous media either through cyclones or electro-precipitation.

Solidification of Castings . . (2nd ed.) . .

R. W. Ruddle. 406 pp. The Institute of Metals, 4 Grosvenor Gardens, London, S. W. 1. 1957. 42s (\$6.50).

The author explains the experimental and research techniques of the subject. He covers the mechanics and mathematics of heat extraction by molds; solidification rates of sand castings; continuous castings; production of sound castings; and thermal properties of metals and mold materials. Mathematical functions, references, and subject and name index complete the book.

The Manufacture of Iron and Steel. Volume I: Iron Production . . . by G. Reginald Bashforth, F. I. M. 2nd edition, revised. Chapman and Hall, Ltd., 37 Essex Street W. C. 2, London. 1957. 45 shillings.

A format supported graphically makes this textbook a reference for both student and industrialist. All phases of blast furnace operation in producing both pig iron and wrought iron are included.

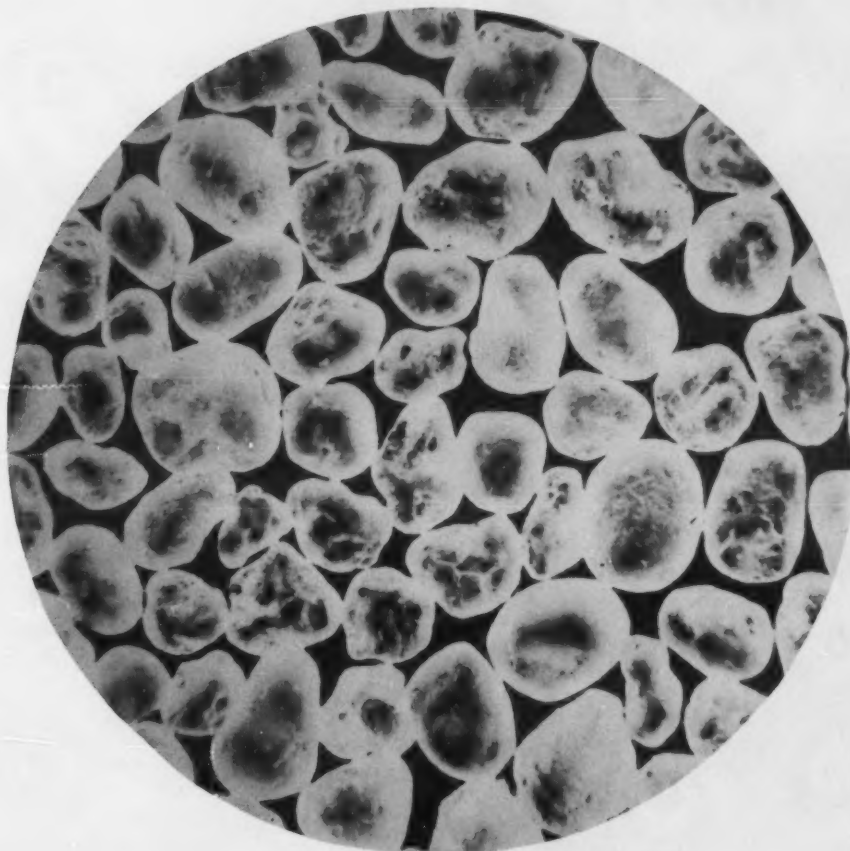
Nickel Circular Revised by Bureau of Standards

■ The phenomenal expansion of the North American nickel industry since 1950, release of previously restricted information, development of new theories of alloying and heat treatment, and the development of new alloys to meet industrial requirements of increasing severity have led to a revision of the National Bureau of Standards circular, *Nickel and Its Alloys*.

The current revision, sponsored by the International Nickel Co., Inc., New York, covers, among other topics; occurrence of minerals and ores throughout the world; recovery and refining, uses, and properties (general, optical, thermal, electrical, magnetic, and mechanical,) of high-purity and commercial nickel; as well as properties and industrial applications of ferrous and non-ferrous alloys.



Send him to the pouring line—they wanted a man with quick reflexes.



The sand in the microphoto above speaks quality. It's pure and fine, with the excellent rounded grain properties so desired for foundry use. This is indeed a superb sand—finest for foundries.

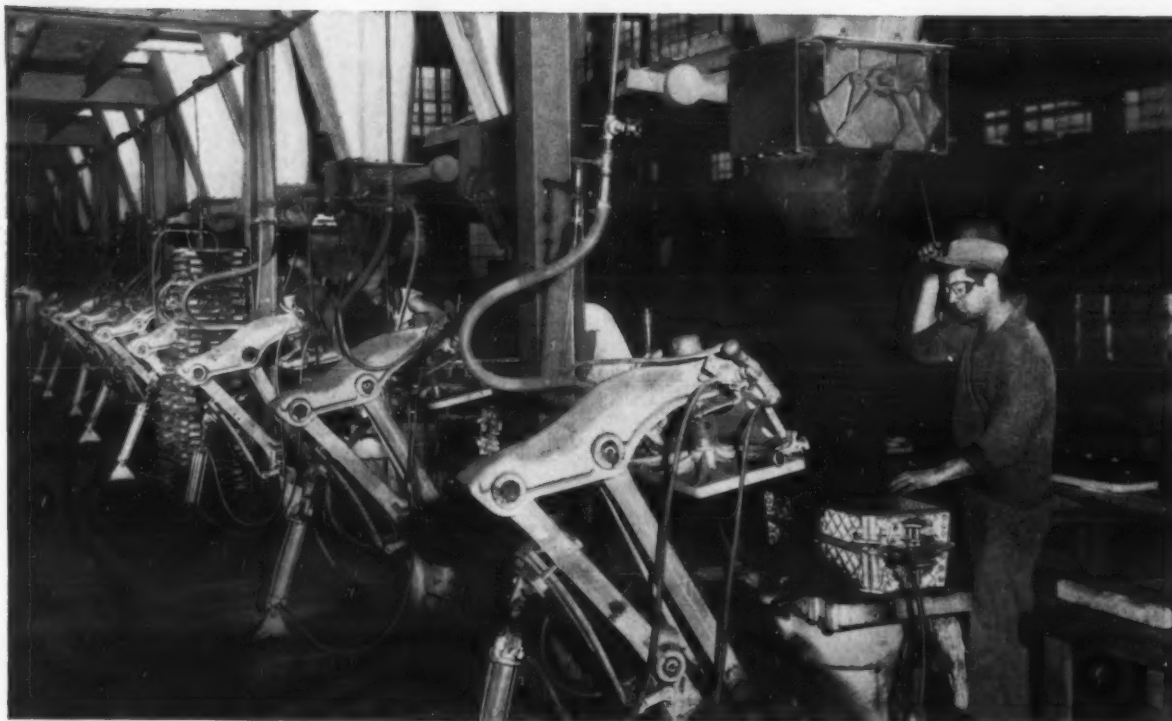
The obvious merits of quality can be yours with Wedron Silica



Send for illustrated brochure on Wedron sands.

Circle No. 745, Page 7-8

JEFFREY helps modernize A. C. Williams Co. foundry at Ravenna, Ohio



Jeffrey hoppers supply sand directly to molders' stations; save considerable time, effort and floor space.



Jeffrey MV conveyors move material with non-sliding, hopping action that assures long deck life; abrasive wear is negligible.

Jeffrey equipment played a major part in improving plant efficiency when A. C. Williams Co. modernized its foundry. Jeffrey overhead sand distributing systems, MV conveyors, aerators and apron conveyors are being used.

You can call on Jeffrey for equipment or for complete system engineering to improve efficiency and to boost profit. Jeffrey engineers are thoroughly familiar with all phases of foundry operations. Jeffrey-built equipment is expressly designed for the high-speed, low-maintenance operation modern foundries require.

Complete information on Jeffrey foundry equipment and service is described in Catalog 911. Write for your copy. The Jeffrey Manufacturing Company, 977 North Fourth Street, Columbus 16, Ohio.



CONVEYING • PROCESSING • MINING EQUIPMENT... TRANSMISSION MACHINERY... CONTRACT MANUFACTURING

Foundries Fail to Realize Epoxy Pattern Advantages

by ROBERT LEMASTER
Nelson Pattern Co.
Milwaukee

■ Because of the sour experience with low strength and dimensional instability associated with the "miracle" phenolic plastic pattern equipment introduced several years ago, many foundrymen have expressed reluctance to accept modern epoxy resins for use as pattern material.

These epoxy resins possess versatility, high strength, high dimensional stability, low shrinkage, excellent adhesion, room temperature cure, and are non-reactive with other materials. The "plastics are plastics" attitude in some foundries which classifies phenolics and epoxies together as having properties equally deficient is unfounded; the difference is as great as the difference between lead and steel.

Three Categories

Epoxy resins are obtained as a by-product from the production of natural gas; formulating companies add fillers and agents, producing resins of varying viscosity, workability, and cost. These resins fall into three basic categories; laminating, pouring, and splining.

Laminating consists of building up alternate layers of epoxy and glass cloth. A laminated plastic shell 1/4-3/8 in. thick will stand abuse as well as present metal patterns with a 1/2-3/4-in. wall thickness.

This fabricating method offers several definite advantages—lightweight, toughness, and chip resistance. In comparison to metal backed plastic equipment it is normally cheaper because it eliminates the master pattern. A lamination of fiberglass and epoxy resin is as strong as a plate of steel of comparable weight.

Most Accepted

Probably the most generally accepted method of construction is the pouring of a 1/4-in. plastic face over a cast aluminum back-up frame. This process offers the strength, reliability, and solid backing of present aluminum equipment at a cost less than machined equipment. Disadvantages of this method are high cost, low fracture resistance, and the fact that it results in heavier equipment than the lamination process.

Splining resins and the technique involved in their use are not being used for pattern construction to my knowledge. The technique is not intended for pattern construction but only to develop complex shapes.

■ Condensed from a talk presented at the 1958 Wisconsin Regional Foundry Conference.

Bright Future for Cast Mg in Missiles Construction

by J. H. Rizley/Chief Materials and Process Engineer and R. E. Mihalco/Metallurgist, Convair Div., General Dynamics Corp.

■ It can be logically assumed that fighter aircraft will eventually be replaced by guided missiles, and that the era of the long range ballistic missile will begin. Missiles now being produced and developed are: air-to-air, ground-to-air, intermediate range ballistic, intercontinental ballistic, and anti-missile missiles.

Provided cast magnesium alloy development can keep pace with competitive metals in factors such as strength/weight and stiffness/weight ratios, magnesium castings will play an increasingly important role in missiles construction.

Light Weight

The light weight of magnesium (aluminum 1-1/2 times heavier, steel 4-1/2 times heavier) is one of its outstanding characteristics. Since excess weight decreases the effective range of missiles, the air-frame industry in particular is constantly evaluating materials in an effort to obtain lighter and more efficient structures. Most magnesium alloys have excellent castability; dimensional tolerances can be held closer than most metals.

At the present time, the largest percentage of airframe castings are produced in AZ91C and AZ92A; booster fins and electronic equipment mounting boards typify components now being made from these alloys. As in the latter case, the ability of magnesium alloys to conduct heat efficiently has made them especially useful in applications of this type.

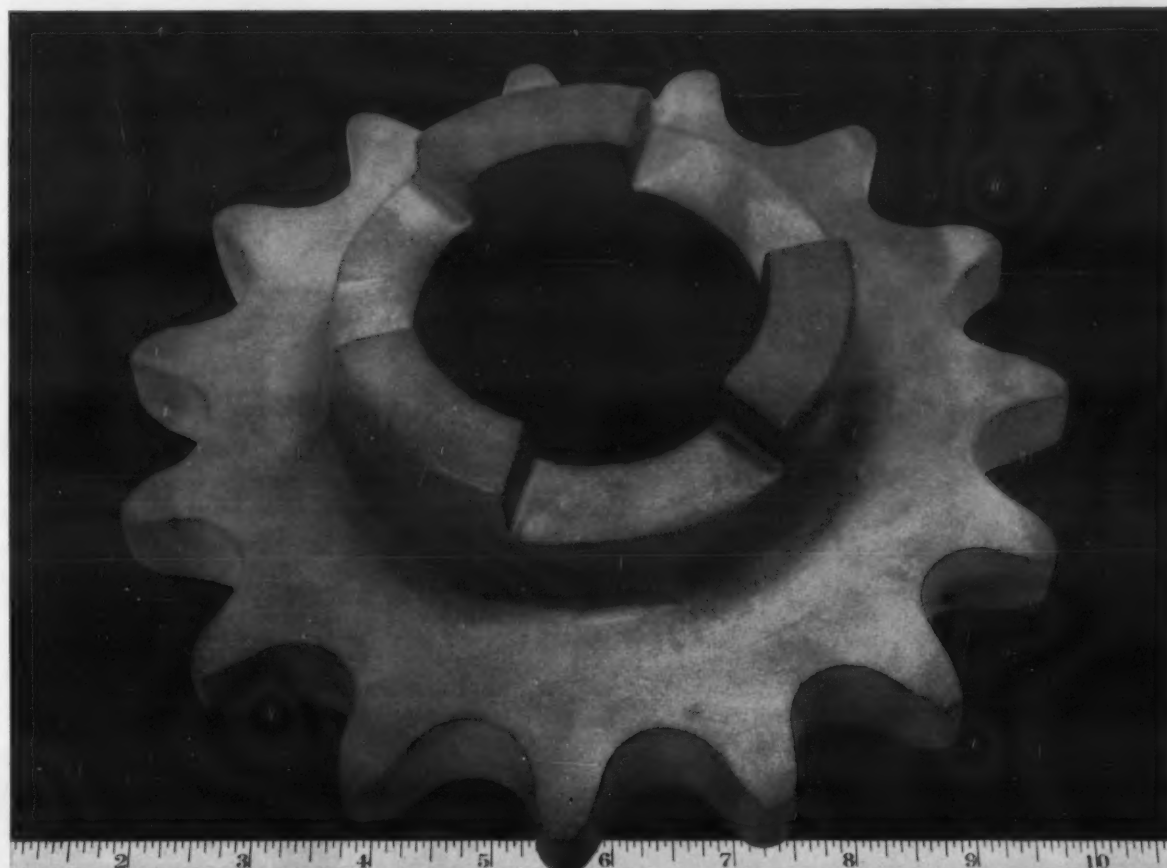
Research Needed

In future designs, magnesium casting alloys which can compete with competitive metals in the 300-700 F range will be needed. It is in this moderate temperature range that magnesium is capable of giving the designer a distinct advantage.

Foundry practice should be improved to assure castings that can pass exacting nondestructive inspection standards to assure structural integrity. Development of improved plaster mold and investment casting techniques is needed.

For use in future designs, a casting alloy showing a 15,000-20,000 psi yield strength in the 500-600 F range would be very useful; however, it is apparent that a good deal of development will be necessary.

■ Condensed from a talk given at the 13th Annual Magnesium Association Meeting.



Actual photograph of a Cast Tooth Sprocket Gear in ASTM: A-148-53T Grade 90-60 Steel made in H-W FORSTERITE GRAINS shell mold by Fort Pitt Steel Division, Pittsburgh Steel Foundry Corporation.

SMOOTH CAST SURFACES result from resin-bonded shell molds of H-W FORSTERITE GRAINS

Forsterite grain is highly refractory magnesium silicate possessing physical properties which make it especially suited for resin-bonded shell molding. Its specific heat, thermal conductivity, high temperature stability and uniform thermal expansion—all contribute to its excellent performance.

As the result of the optimum chilling effect of forsterite grain, sufficient strength develops in the skin of the steel casting to resist outside gas pressure as well as inside ferrostatic pressure, and

a smooth casting surface is assured.

H-W FORSTERITE GRAINS are supplied in controlled sizings best suited for securing the most satisfactory shell molded casting surfaces.

H-W FORSTERITE FLOUR is furnished for use as an additive to the H-W FORSTERITE GRAINS and resin mix to provide for the ultimate in surface smoothness, particularly of castings with heavy sections. Write for bulletin No. 6.

HARBISON-WALKER PRODUCTS WILL BE EXHIBITED AT THE FOUNDRY SHOW, BOOTH No. 305



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World's Most Complete Refractories Service
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PREVIEW of TOOLS and TECHNIQUES for TOMORROW

No alert foundryman can afford to pass up the opportunity to attend the 62nd AFS Castings Congress and Foundry Show in the Cleveland Auditorium, May 19-23! Here you can personally inspect the very latest and most up-to-date Tools and Techniques for Tomorrow's Metalcasting Industry.

row's Metalcasting Industry.

Over 225 leading companies will occupy 100,000 sq ft with exhibits. This spectacular of modern casting technology and know-how is a must in every foundryman's agenda in these challenging times.

The following pages present a

preview of the industrial cornucopia of products and processes that you will see at the 5-day Show.

Additional information about the products described in this partial list are yours for the asking. Use the Reader Service card, page 7-8, to send your request.

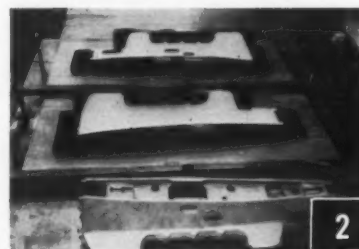


PATTERNMAKING

No casting can be any more accurate than its pattern! Castings buyers are demanding more and more precision. Patternmakers are meeting this challenge by using the new pattern materials and equipment that will be exhibited in Cleveland, May 19-23.

Epoxy compounds for patterns—Houghton Laboratories Inc. will exhibit its epoxy compounds for the production of patterns, core boxes, and dielectric driers. These Hysol materials are said to reduce the cost and time in producing foundry equipment. Photo illustrates a cast Hysol epoxy core box. **1**

Plastic pattern materials—Epoxy surface coatings and plastic laminating materials are facilitating the manufacture of critical tolerance tools such as duplicating masters,



keller models, cope and drag patterns (photograph), match plates, core boxes, master models, and checking fixtures. In fabrication of the cope and drag pieces shown here, Epocast 7A Gel Coat, Epocast 2D Laminating resin, and Epocast 2D sand binder were used. *Furane*

Plastics Inc. will demonstrate these products at the Foundry Show. Colored safety hardeners are used in conjunction with these materials to provide a selection of colors for identification and coding. They are said to be water repellent, giving extreme stability when used with Furane materials. **2**

Sugar pine lumber—A lumber made especially for patternmakers, Perfect Plank, will be demonstrated by *High Sierra Pine Mills, Inc.* The material is said to be stress-free; resists warping, twisting, checking, and splitting after carving. Perfect Plank is stated by the manufacturer to be 100 per cent usable and clear, with no hidden defects. Sugar pine has nearly twice the dimensional stability of standard flat-grained lumber; the center of each standard 18-in. wide plank is said to be as dry as the outside. Picture is of a 12-stage pump case pattern made entirely of Perfect Plank. **3**





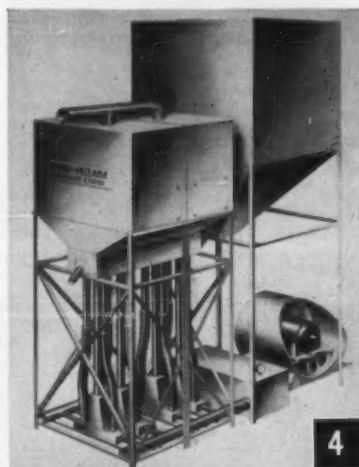
SAND CONDITIONING, HANDLING, RECLAMATION

■ No material is more basic to the foundry industry than sand. As the number one medium for making molds and cores it is not surprising to find a large proportion of the exhibits devoted to the handling, conditioning, and reclamation of sand. Mechanization, then automation are taking over these daily chores.

Sand reclamation unit—Samples of used sand will be reclaimed at the Show, the same as would be done in an actual foundry operation, for reuse in core and molding mixtures. The Pneu-Reclaim Sand Reclamation Unit, manufactured by Beardsley & Piper Div., Pettibone Mulliken Corp., will be used for the demonstration. In addition, their exhibit will include a "dry run" operation on multiple station Slinger Roto-Mold Unit and Roll-A-Draw. Among other units exhibited will be Shell Flexible Shell Coreblower; its ability to handle various core sand mixtures will be demonstrated. **4**

Pneumatic conveyor—Powdered and granular foundry materials are transported to molding and other work stations, without manual handling by means of the National Transporter, to be shown for the first time by National Engineering Co. Adjustment of the air pressure used to convey materials is accomplished with adjustable air jets which increase or reduce amount of air entering the conveying system. The new transporters are available in 7-1/2, 15, 30, and 40 cu ft capacities. **5**

Portable sand conditioner—Foundries seeking more efficient methods of sand reclamation and conditioning will be interested in the latest product by Royer Foundry & Machine Co., the Mag-na-San sand conditioning unit, which cleans, mixes, blends, and aerates up to 45 tons of sand per hour. Unit also features magnetic

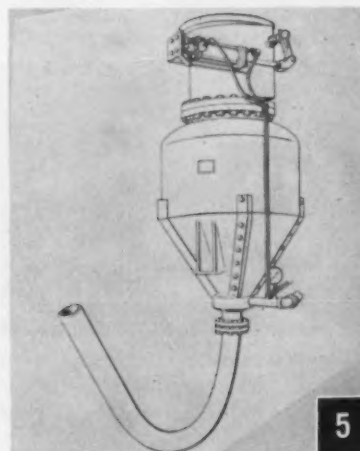


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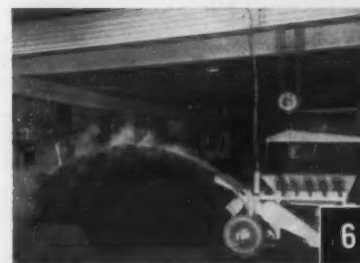
separation of ferrous scrap, and an adjustable discharge stream for piling or windrowing from 5-20 ft. A turning radius of 6-1/2 ft permits easy maneuvering. **6**

Vibrators for sand feeders—Automation of foundry operations such as feeding sand into core machines is accomplished with CV-35 Vibrators, which will be demonstrated by Martin Engineering Co. The manufacturer claims maintenance-free service for as long a period as several years. The Vibrator at upper left is turned on manually when needed. The unit attached beneath chute is connected to operate automatically when machine crosshead is in load position. Units said to operate silently. **7**

Sand system free of elevators—A new sand system makes it possible for small foundries to afford a mechanized sand system because sand is elevated and conditioned simultaneously on an inclined conveyor belt. The Pekay Machine & Engineering Co., Inc., states that the low price is made possible by eliminating the many material handling units with this new system. A model sand system free of elevators will be displayed at the Foundry Show. **8**



5



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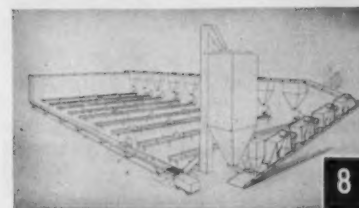
Sand mixer with rubbing action—Designed for thorough blending of sand binders such as sodium silicate, air setting, resin, core oil, etc., without crushing or heating; the Whirlmix will be exhibited by the San-Blo Dept., Archer-Daniels-Midland Co. The company states that all models will thoroughly mix their maximum capacities within three minutes, and smaller batches in less time. Replaceable rubbing shoes on the end of the mixing arms rub the sand between the outer wall of mixer, assuring thorough mixing with a minimum amount of binder. Discharge door is high enough from floor (28 in.) to facilitate loading conditioned sand to wheelbarrows. **9**

Sand mixer—A new sand mixing machine incorporating a unique design which is "doughnut" shaped so as to eliminate the slow moving

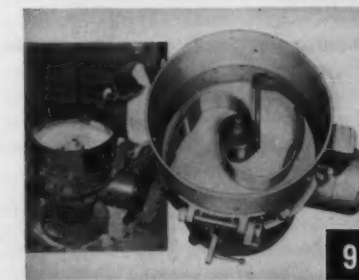
center area of "pan-type" mixers will be displayed by Illinois Clay Products Co. Blades are positioned to produce braiding mixing action in the new Turbine Mixer; mixing action is at 9 feet per second. Advantages of machine are said to be production of a better sand, saving of binder, and economy of installation. **10**



7



8



9



10



SAND MOLDING

■ Castings owe their competitive position to sand probably more than any other single material used in the foundry. Sand molds are made from an inexpensive widely available material that lends itself equally as well to hand molding in job shops or high speed mechanized molding in production shops. Here are a few of the items that you will see at the Show helping sand molds lead the field.

Automatic straight draw machine—*British Moulding Machine Co. Ltd.*, has added to the growing list of automated equipment for foundry operations. For the first time at the Foundry Show, the company will demonstrate its push button automatic straight-draw machine with a pneumatic controller capable of running the machine through all operations in from 6 to 60 seconds. In addition, a turn-over type machine will produce the cope and drag molds in pop-off flasks with Nomad pallets and rails.

11

Automatic Shell molding machine—A versatile shell molding machine, operating either single or repeat cycle, and fully automatic, will be demonstrated at the Foundry Show by *Hutchinson Shell Mold Co.* The sand investment operation is accomplished in one rotating movement; the dump box is automatically retracted after being inverted over the pattern. The Hutchinson Shell Mold Machine eliminates all latching, clamping, or reciprocating requirements. The dump box is equipped with a set of fixed louvers. Gas heated, the machine provides selective heating for each side by means of an adjustable damper. Continuous heating is maintained under the patterns.

12

Resin for coating sand—Used with the cold coating process



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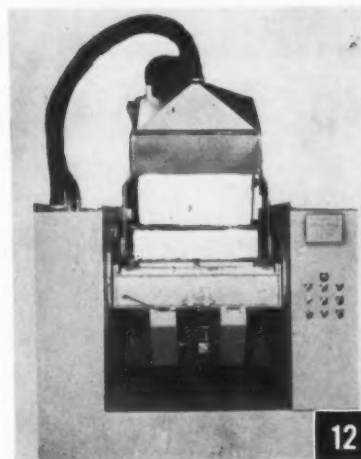
(blended alcohol and water as a solvent), an improved resin for coating sand, Durez 18250, is said to add new economy to the production of accurate castings. *The Durez Plastics Div., Hooker Electrochemical Co.*, will exhibit samples of shell molds, cores, and shell mold castings made with this material at the Foundry Show. The manufacturer claims that cold strength of shells and cores is up to 30 per cent greater, and hot strength also superior, with use of Durez 18250; and, in addition to a shorter mulling time, fast curing properties of this resin result in

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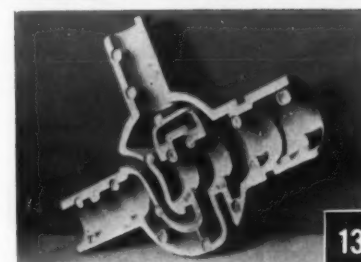
Shell sand coating unit—Sand coating units made to suit customer's specifications as to materials or coating process used are offered by *Sutter Products Co.* The Uni-pak-Coater is offered as a package; the operator automatically controls the sand supply, the sand heating, coating, crushing, screening, and delivery to shell making machinery. The unit is said to be capable of coating sand at the rate of 6000 lb per hour; and includes a sand elevator or skip hoist, receiving hopper, combination vibrating feeder with heater, coater with built-in opening doors, crusher rolls, vibrating screen, collecting system, and storage hopper.

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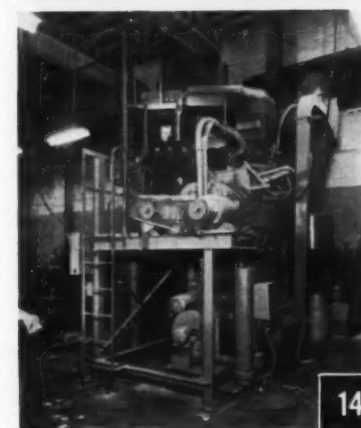
Zircon coating for cores and molds—A high percentage of zircon flour provides a refractory value of over 3000F for this new zircon wash designed for coating all types



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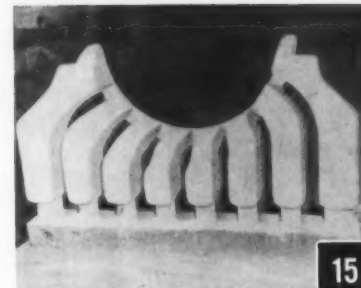


14

of cores and molds. Kold-Set Zircon Wash, manufactured by *G. E. Smith, Inc.*, is composed of zircon flour, binder, wetting agent, and suspending agent. The wash is said to set up a hard, heat-resistant shell around the core or mold which produces castings with good surface quality. Manufacturer reports this new wash eliminates runs and tear dropings.

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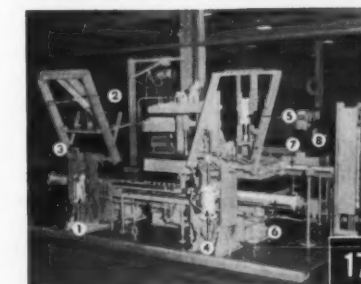
Sand mixer for resin coating—A machine capable of coating up to 3000 lb of sand with resin per hour will be introduced for the first time by *C & S Products Co., Inc.* A rotary drum heats sand to 350 F, and



15



16



17

charges it into a twin-shaft pugmill where the coating operation takes place. Sand is then discharged from a special screen. Machine is available in manual, semi-automatic, and fully automatic models.

16

Air cylinders for automation—Miller Air Cylinders are contributing to automation of foundry operations, such as this double jolt foundry molding unit which utilizes fluid power in its main lifting, lowering, shuttling, and push-off operations. The 8 air cylinders indicated in the picture accomplish the automatic operations of the cope and drag cycles, including the jolting, shuttling, and push-off operations of the complete operation. *Miller Fluid Power Div., Flick Reedy Corp.* produces its All Teflon Seal Cylinder with the Shef Seal said to resist shearing, heat, extrusion, and fluids. Power Packed line of cylinders has 3000-5000 psi ratings.

17

Zircon sand and flour—A complete display of zircon sand and flour will be manned by *Orefraction, Inc.* personnel to assist foundry men in the beneficial and economic use of zircon.

Carbon sand molding material—A new molding material designed as a replacement for, or an addition to, molding sands, composed of screened particles of carbon, will

be displayed by the *J. S. McCormick Co.* The Carbon Sand is twice as light as silica sand, and three and one-half times as light as zircon sand. No. 100 Carbon Core mixes have been found to completely eliminate or materially reduce metal penetration; to stabilize molding sand, reducing expansion and contraction; to withstand heat and ferro-static pressure; and to withstand the wetting action of molten

metals. Cores made of this material are said to save many hours cleaning time because of the ease in which they are removed from the casting.

New type chill nail—A new chill nail which is twisted at the top, a feature which *Standard Horse Nail Corp.* says, "makes the difference" in effectiveness, will be on display as a new addition to the Koolhead

line of chill nails. The New Twist nails are offered per 100 lb, and are coppered or tinned to order. Free samples are available on request.

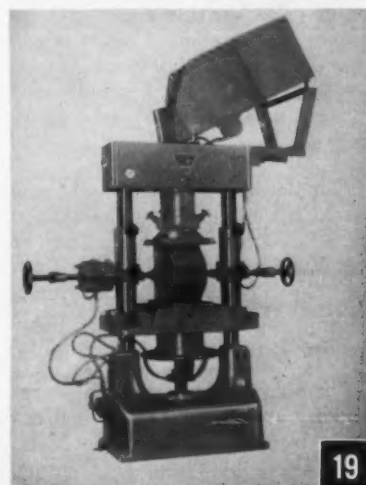
Molding machines—The *Herman Pneumatic Machine Co.* will show latest developments in the company's line of molding machines. Both the standard and the special machines will be demonstrated.



COREMAKING

■ One of the greatest competitive advantages of the metal casting process is the ability to form complex internal cavities by the skillful use of cores. Here are a few of the new core making materials, binders, processes, and devices that will attract the attention of thousands of foundrymen attending the 62d Castings Congress and Foundry Show.

Oil-type binder—An oil-type binder which is said to bake in di-



electric ovens at a rate equal to thermosetting resins will be exhibited by the *Penola Oil Co.* Penola 75 Core Binder can be stored indefinitely, will not irritate the skin, has no offensive odor, and has the clean workability and baked properties characteristic of oil-sand cores.

Two-second core blowing—A new core blower machine developed by *Osborn Mfg. Co.* will be demonstrated at the Foundry Show. The single station Core Blower Unit No. 906 is said to perform the core blowing cycle in two seconds per core. The machine features jet stream sand feeding directly into the core box, a hydraulically adjustable machine table which locks to optimum core box space, either the Jet-Blow fun-

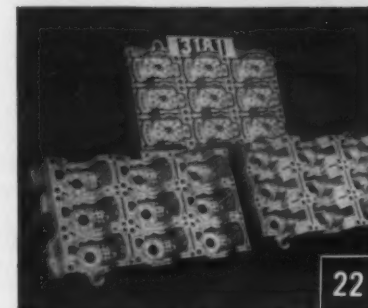


nel head or Reservoir Head with quick change blow plate, and compact design to save floor space. A small number '18' is in the bottom right corner.

Core shooter—*Carver Foundry Products Corp.* will display the latest in its line of V & S Core Shooters, the Model KSA 210, said to make even the most complicated cores in less than one second. Completely automatic, the unit is operated entirely by compressed air. Fast change-over for short-run jobs, greater economy on air, and harder ram that assures high stand-up cores out of stiffest sand are benefits claimed for this product. A small number '19' is in the bottom right corner.

Core and mold spray—Surface hardness of cores and molds is improved when surface sand is tied down. A new air-drying spray, *Top Bond*, is said to do just that. *United Oil Mfg. Co.* will display this new product, said to give cleaner castings at the shakeout and to prevent sand inclusions. Green sand cores sprayed with *Top Bond* are reported to produce the hardness of a baked core. A small number '20' is in the bottom right corner.

Liquid core paste—*Frederic B.*



Stevens, Inc. will demonstrate its improved Fastick liquid core paste which the company claims may be used equally well with CO₂ cores, shell molds, resin bonded cores, and oil sand cores. The drying time of the paste has been speeded 10 per cent, will pour a steady stream.

CO₂ core hardening chamber—uses multi-cycle application of pressure and vacuum to produce cores said to have about double the as-gassed strength and with 40 per cent longer shelf life than straight pressure-gassed cores. *Alphaco Gasser*, produced by *Alphaco, Inc.*, is available in 2-1/2 and 27 cu ft capacities. Smaller unit cycles in 10 sec. Eliminates over-gassing, thus saving gas and controlling moisture deterioration.

Vertical core baking ovens—This battery of baking ovens, each standing 70 ft high, and measuring 15 by 15 ft, were designed by *The Carl Mayer Corp.* The ovens are

direct gas-fired, and employ a recirculating type air heating system. Hardened cores are automatically unloaded on a roller conveyor system which is an integral part of the installation. **21**

Core box sealing—Full utilization of core blowing equipment can be realized by sealing multiple cavity core boxes, as shown here, to eliminate blow-by and rattling or piping holes; and to greatly reduce fin-

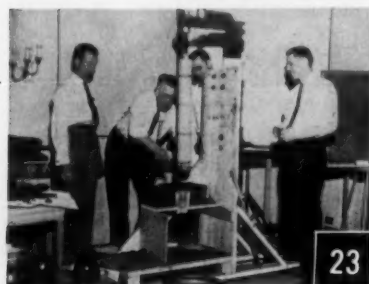
ning, mudding, and patching. Dike-O-Seals, manufactured by *Dike-O-Seal, Inc.* are used in the company's patented core sealing process said to make possible and practical the ganging of cores regardless of complexity of parting faces. Dike-O-Sealed core boxes, which the manufacturer claims have a proven record of delivering cores of consistent quality, accuracy, and permeability, will be exhibited at the Foundry Show. **22**



METAL, FLUXES, REFRACTORIES

■ Super refractories and revolutionary melting techniques are responsible for the new demands being met by metal castings at elevated temperatures, speeds, and forces. Many of these new developments will be unveiled in the big 100,000 sq ft AFS Exhibit in Cleveland.

New alloys for cast iron—Foundries interested in producing spheroidal graphite in cast iron will see a new line of alloys developed for this purpose at the Foundry Show. The new Ductimet alloys will include nickel-magnesium copper-magnesium, and iron-magnesium, with or without silicon or cerium. *Alloy Metal Products, Inc.* will produce special combinations of these elements for the individual foundry needs. The company also makes specification remelting alloys of nickel, copper, and cobalt base under the name of Alloymet.



Stopper rod refractory—This model is used both for display purposes and for training field representatives of the *Joseph Dixon Crucible Co.* It is composed of a stopper rod refractory set-up, using ladle rigging, refractory sleeves, Dixon graphite stoppers, Dixon's P-7 Mix, and the company's non-graphitic super refractory nozzle, which resists corrosion. P-7 Mix is tamped into place around nozzle, and is said to resist erosion from pouring action of the steel. **23**

Light weight ingots—In order to



alleviate the handling and storage problem posed by heavy and hard to handle ingots of brass, bronze, aluminum, zinc, etc., *R. Lavin & Sons Inc.* has developed a new series of ingots with dimensions, compactness, and smoothness said to afford new ease of handling, stacking, and storage. The new ingots reduce the melting time, and increase the number of heats which may be poured. They are shaped so that they may be palletized to save time and to speed delivery. **24**

Cupola lining machine—A new machine for lining cupolas will be introduced for the first time at the Foundry Show by the *Eastern Clay Products Dept., International Minerals & Chemical Corp.* **25**

Pneumatic refractory gun—A refractory gun which is operated entirely by the nozzle man will be displayed by *National Foundry Sand Co.* Completely automatic, the Jet-liner's four-speed transmission enables varied capacities up to 11 tons per hour. Unit is designed to handle up to 12 per cent moisture in pre-mixed materials. Present foundry applications are lining labels, runners, electric furnaces and cupolas. **26**

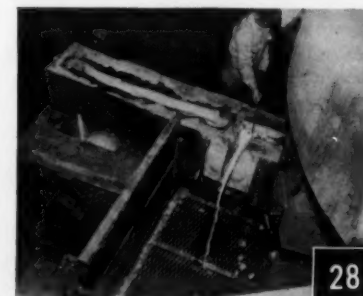
Desulphurization—A new process has been developed by *Diamond Alkali Co.* for externally reducing the sulphur content in cupola iron. Molten iron and alkalies are fed continuously into this rotary reactor, said to make efficient low-level desulphurization possible. Information about this process will be available at the Foundry Show; in addition the company's Foundry Grade Ash and Moroc, a controlled silicate CO₂ binder will also be displayed. **27**



Brass and Bronze ingots—Better alloys in ingot form for foundry use are said to be produced by *Interstate Smelting & Refining Co.,* through the use of the company's own revolving furnaces, claimed to give better control of the metal while it is being produced. Many alloys are produced to customer's specifications; besides alloys produced to standard A.S.T.M. and federal specifications.

Carbon fortified refractory block—A refractory lining material fortified with carbon, and available in slices or powdered for ramming; or as a ladle wash for spraying or brushing on over existing linings, will be exhibited by *Sivad Ceramic Corp.* Among other benefits Dragon lining materials are said to resist slagging, penetration and abrasion, and to outlast other refractory blocks five to one.

Ramming refractory—A newly developed fused alumina-base ramming mix, Starrlum 6511-C, for spouts and ladles will be demonstrated by the *American Refractories & Crucible Corp.* Photograph shows a front slagger pouring spout and the forehearth ladle rammed with the new mix. Said to be engineered for the most severe applications, the new ramming mix has an installed weight of 184 lb per cu ft. **28**





MELTING and POURING

■ Faster melting, higher super-heating temperatures, closer control of slag and metal chemistry, vacuum melting and degassing—all these new melting techniques and more will be among the 225 industrial exhibits at the AFS Show.

Graphite electrodes for electric furnaces—Foundries interested in determining how to improve the quality of melt from their electric furnaces need to know how graphite electrodes affect this quality. *Great Lakes Carbon Corp.* will exhibit its line of electrode columns including the GLC graphite electrode with the "weld-strength" Uni-trode nipple, said to produce better steels at lower costs.

Vacuum degassing chamber—Up to 1000 lb of molten metal can be degassed in ladles or crucibles at pressures below 200 microns in Model 400 Vacuum Degassing Chamber made by the *Centrifugal Casting Machine Co.* Depending on the type of metal being de-



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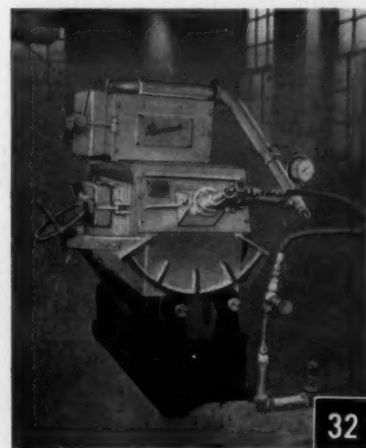
gassed, the entire cycle, from placing molten metal in the chamber, to opening it and lifting out the crucible ready for pouring, takes from 6 to 15 minutes.

29

Furnace melting station—Designed to add new efficiency to melting, the new TOCCO furnace melting station will be shown by *Ohio Crankshaft Co.* Unit contains all necessary components required for melting except a motor generator, starter, and furnace. The station is designed for melting ferrous or non-ferrous metals in tilt or lift type furnaces, or consecutive operation; and air or vacuum melting, or consecutive operation. Unit is said to offer optimum safety and new simplicity to melting station operation.

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Electric furnace—Included in the line of melting equipment manu-



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factured by *Lectromelt Furnace Div., McGraw Edison Co.*, is the latest design of the Lectromelt furnace which pours a 12-ton heat of steel in about two hours. This furnace incorporates features of power operated electrode holders, four-point suspension of the roof ring with a quick release attachment, oversize roof rings, hydraulic tilting. Unit has a shell diameter of 11 ft.

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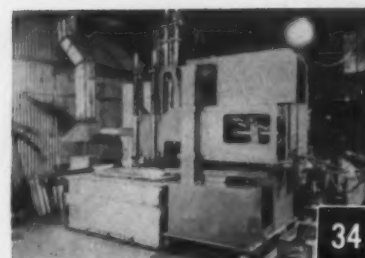
Melting furnace—Faster melting, said to hold gas inclusions to a minimum, is one of the features of the Revecon Furnace, 50/150, to be displayed by the *International Foundry Supply Co.* The furnaces are oil, gas, or coke fired with melting capacities from 50 lb to 5 tons. Melting rates are: 100 lb of aluminum, in 10 minutes; 200 lb of brass, in 20 minutes; and 100 lb of iron, in 45 minutes. The manufacturer claims that faster melting results in better metal than that produced in longer heats in crucible-type furnaces. The Revecon furnaces are said to hold the metal loss in the melting of ingots to below one per cent on aluminum, and two per cent on bronze.

32

Furnace with removable crucible—Transfer time in melting operations is saved with a new Inducto "Push out" furnace featuring a removable crucible which is raised from the furnace hydraulically for easy removal by tongs to the pouring area. *Inductotherm Corp.* makes the double furnace which shifts power to an alternate crucible when the charge is ready for pouring. The operator's controls are mounted on the furnace for convenience and accessibility.

33

Automatic slug casting machine—Of particular interest to metal extruders and forgers is this machine



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for casting of non-ferrous slugs to specific length and diameter for impacting or forging. Slugs made from ingot or scrap metal by the Come-Cast are said to require no tumbling or processing for burr removal. Castings are deposited from a chute on the end of the machine. The manufacturer, *Stroman Furnace & Engineering Co.*, states that there are very few restrictions on the number of the alloys which can be cast with this machine.

34

Automatic ladling furnace—Automatic processing of castings such as aluminum die casting and permanent mold is possible with new electric melting and holding furnace to be exhibited by the *Lindberg Engineering Co.* Precise, accurate control of any size shot within range of the unit is claimed for the automatic ladle which withdraws metal from beneath the surface of the bath. The pressurized chamber principle is utilized, with the size of the shot depending on time and amount of pressure. Standard equipment supplies 1-30 lb of aluminum; other sizes are available. Heating units of the furnace are installed so that they may be replaced without shutting them down. The furnace has a holding capacity of approximately 2000 lb of aluminum.

35



SHAKEOUT, CLEANING, FINISHING

■ After the metal casting has solidified in its mold it starts a long trek through shakeout, cleaning, and finishing. A multitude of materials, devices, and techniques for cutting, grinding, and smoothing castings will occupy a considerable floor area at the Show. Speed and economy are being built into these operations.

Metal removing torches—Castings repair, flash removal, and foundry applications involving metal removal are operations for which *Arcair Co.* has designed its line of heavy duty torches. The G-55, M-6, and G-6 models are said to be especially suited for foundry use, using electrodes of from 1/2- to 3/4-in. Models will be exhibited at the Show.



36

Grinder—A new stand grinder combining rugged construction with wide clearance said to easily handle odd-shaped castings will be displayed by *Fox Grinders, Inc.* The Fox 1-30 has a 30x3x12 wheel size, is powered by 20 h.p. motor, and is equipped with full speed changing device.

37

Grinder—In line with the campaign for better air pollution control, the *United States Electrical Tool Co.* has added a dust collector to its Model 500 general purpose grinder. The dust collector is built into the base of the one, two, and three hp models of the grinder. It draws polluted air down into a filter cabinet, forces it through a fibre glass pad, and returns the cleaned air to the room from the top of the cabinet. The new unit, rated at 1000 cu ft per min., 4-in. pressure, is 32-1/2 in. wide and 20 in. deep.

38

Airless Blast Cleaner—*Wheelabrator Corp.* will demonstrate its Super Tumblast airless blast cleaning machine at the Foundry Show; the machine is said to bring new efficiency to the cleaning of castings; saving abrasive, wearable parts,

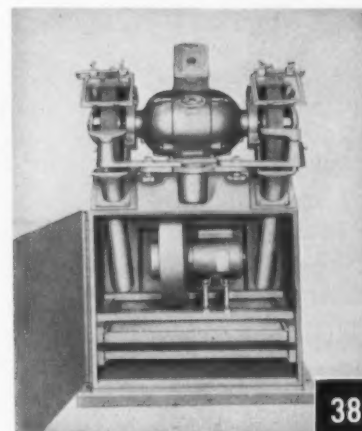


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cleaning time, man hours, and maintenance. New sealed construction is claimed to increase the abrasive reclamation. Manufacturer reports that the abrasive costs have been reduced as

39

New Pearlitic abrasive shot—In addition to the complete line of metallic abrasives of the *Cleveland Metal Abrasive Co.*, the company's exhibit will include samples and descriptive data of the new A shot and grit, and Pearlitic Malleable shot. The manufacturer claims to be the worlds' largest producer of abrasives of this type.



38



39

New welding alloys—Latest developments in castings repair include the development of two new welding alloys for joining or correcting castings of iron or aluminum, Xyron 2-24 AC-DC and EutecTrode 2101 DC. These alloys developed by *Eutectic Welding Alloys Corp.*, will be continually demonstrated at the Show. Eutec-ChamferTrode, used on gates, risers, and for cutting out inclusions, will also be shown.



MATERIALS HANDLING

■ It has been said that 200 tons of materials must be moved in the foundry to make one ton of castings! Every foundryman should take a close look at the many cost-cutting ideas in materials handling which will be demonstrated at the Show in the Cleveland Auditorium.

Mobile car mover—Foundries

seeking to mechanize in-plant rail car handling will find an improved model of the *Whiting Corporation's* Trackmobile on exhibit. The Trackmobile is a tractor with two sets of wheels; one for road use, one for rail use. The unit to be exhibited at the Show has been made more powerful than previous models by the addition of a six cylinder

engine and a torque converter-hydraulic transmission combination. Drawbar pull of this tractor, known as the Torque Converter Trackmobile, is said to be 13,000 lb; enough to move several fully loaded freight cars.

40

Lift truck—With safety and versatility in materials handling of prime importance, this new lift truck should be of interest to foundrymen. The new Triplex Mast, made by *Yale & Towne Mfg. Co.* combines extra high stacking (up to 216 in.) with improved operator visibility and added channel stability. Multi-stage lifting cylinder requires only two lift chains,

leaving the rest of the space between cylinder and uprights open, increasing visibility. Shorter cylinder length also affords better visibility. Triplex Mast trucks are offered in over-all heights of 59-96 in., giving maximum fork heights of 108-216 in. Truck pictured here slips easily through a 72-in. doorway.

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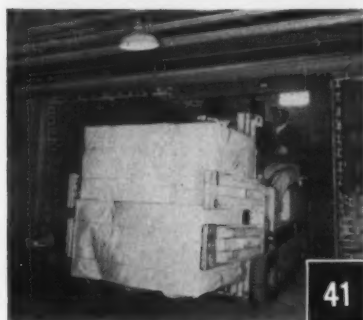
Hot material conveyor—*Cleveland Vibrator Co.* will exhibit a vibrating conveyor designed for high temperature foundry applications. Simplified maintenance is another feature incorporated in the design of this new unit. Conveyor has only one moving part and is



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automatically lubricated. Vibration is supplied by an air powered drive mechanism, which operates at 25 psi. Conveying rates are adjusted by changing air pressure through a standard regulator. Conveyor will feed on the level or up a grade.

42

Materials handling tractor—Materials handling operations of digging, transporting, dumping, and unloading are combined into one versatile unit, the Model HA Payload tractor shovel, manufactured by *Frank G. Hough Co.* A turning radius of 6 ft 11 in. enables unit to quickly maneuver into tight places and turn around in aisles. Hydraulic control dumps the 12 cu ft buck-

et at any height, as fast or slow as desired, and over hoppers up to 68 in. high. Full, 360 degree visibility is an additional feature of machine.

43

Air-powered hoist—A new hoist for materials handling will be demonstrated by *Master Pneumatic Tool Co., Inc.* The Master Power 105 Series features 1000 and 2000 lb capacities, with options of roller or link type chain, and manual or pendant type controls. The pendant control uses fewer parts than conventional hoist controls, which are said to be amply protected from dirt and external damage. The lift, descent, and stop control is reported to be entirely new, elimi-



44

nating levers, valve stems, and other external parts subject to damage from dirt or abuse.

44

Casting cooling conveyor—Conveyors and shoots that collect and cool castings from the shakeout line will be on exhibit by the *Carrier Conveyor Corp.* Stationary hoods collect and discharge hot air after it has been drawn over hot castings. In this picture, the stationary hood and the exhaust are shown over the upper cooling conveyor.

45

Oscillating screening conveyor—*Link-Belt Co., Chicago*, will exhibit a complete run-around conveying system, featuring this oscillating conveyor with a 10-ft screening section. Sand falls into lower trough, while castings and sprue travel on top, which serves as picking table. A divider channels all material to one side of the



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trough; operator manually flips castings and sprues over the divider to far side of trough. They are then discharged over the end of the trough for further cooling. Refuse sand drops into tote box. Coilmount and Torqmount oscillating conveyors will be shown in use; material will be fed from a hopper by a vibrating feeder to the Coilmount conveyor. It will then travel to the Torqmount conveyor, to a belt conveyor, and back to the hopper.

46

polyethylene; and contains a four-ounce squeeze bottle of Fogpruf and a package of 200 Optical Wiping Tissues. Hold goggles an in. from spray head on top, push the button on left, and unit sprays cleaning liquid on both sides of lenses. After liquid dries, lenses of lenses. After the liquid dries, lenses are wiped clean with tissues from dispenser. Used tissues are discarded in the top of the cleaning station.

47

Prefabricated roof exhauster—A light-weight aluminum air exhaust unit for roof installation, the Aluma-



SAFETY, HYGIENE and AIR POLLUTION CONTROL

■ No foundry can run away from its obligation to provide a better working environment for its employees and to preserve good relations with the surrounding community. Come to the Show to see a wide variety of the equipment

designed to make the foundry a safer, healthier place to work.

Goggle cleaning station—A new advancement in plant safety, the M-S-A Goggle Cleaning Station, for quick, efficient cleaning and

fog-proofing of safety goggles, will be demonstrated by the *Mine Safety Appliances Co.* The cleaning station is easily mounted on the wall or machine; takes up little space; and is simple to use. It is made of aluminum and high impact



47



48

lung Roof Exhauster, will be displayed by the *Iron Lung Ventilator Co.* This unit is of one-piece construction; the manufacturer reports that it may be hoisted and installed in a few hours by two men using ordinary tools. Complete aluminum construction eliminates need for painting or other rust protection. The exhauster features compactness, only 21 in. tall, the unit is usually not seen when installed behind parapet walls. Company officials state that the Alumalung blends in easily without distracting bulkiness among all types of architecture. Damper hinges are built so that need for lubrication is eliminated. Fanblades are aerodynamically designed to prevent motor overload. Said to be completely leak-proof, sizes range from 20-60 in. with capacities of 3800-42,000 cfm.

48

Foundry sweeper—Making the foundry a better place in which to work is the goal of maintenance equipment such as this new *Tenant Model 80 Power sweeper* which officials of the *G. H. Tenant Co.* claim it makes sweeping nearly 100 per cent dust-free. The high-powered vacuum machine turns on a 65-in. radius, and can empty loads of 800 lb in 10 seconds through utilizing hydraulic dumping.

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Tumble mill liners—Research on the adverse affect which excess noise can have both on employee efficiency and health has resulted in development of rubber liners for reducing noise in tumbling mill operations. Resist-Abrade liners are said to reduce noise well below the damage risk level. These liners will be exhibited by the *A. I. C. Engineering Co.* which states that, in addition to excellent wearing qualities, the liners tend to shorten the tumbling time.

50

Dust collector—A model molding line showing dust-collecting and ventilation facilities for a mechanized molding loop will be shown by the *Claude B. Schneible Co.* In addition, the company will exhibit a pair of cupolas with their "SW" spark arrestors operating. A three step approach of converting the initial investment to higher efficiencies demanded by changing codes will be demonstrated with this equipment.

51



TESTING and INSPECTION

■ Quality control is a must for producing quality castings. Every step in the casting process must be under surveillance with accurate testing and inspection equipment. The very latest in ultra high speed chemical analysis apparatus will vie with rapid non-destructive testing devices for the attention of the many metalcastings men on-hand for the biennial event.

Fluorescent inspection kit—*Magnaflux Corp.* will exhibit the ZA-43 Zyglo Kit which locates cracks and porous areas open to the surface of non-ferrous castings. Liquid penetrant is sprayed on the surface of the casting, allowed to soak, and surface wiped clean. Inspection with black light (ultra violet) after application of developer compound will reveal any surface imperfections, which will glow as the light falls on them.

52

Controlling and indicating pyrometer—Improved dependability in electronic controlling of fuel and power consumption is said to be offered in the new, compact *Alnor Pyrotroller* which will be displayed by *Illinois Testing Laboratories, Inc.* Requiring 1/3-sq ft of panel space. Unit needs no repeated adjustment, and requires no pre-selection of standard vacuum tube. Laboratories claim new pyrometer offers new simplicity of operation in addition to lower initial and maintenance costs.

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Oxygen Analyzer — Laboratory



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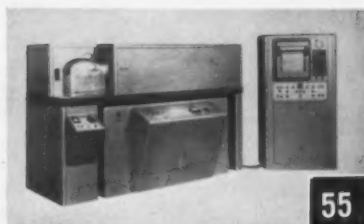
54

Equipment Corp. will exhibit the *Conductometric Oxygen Analyzer* said to give rapid, accurate, and simple determination of oxygen in steel and other metals. Instrument has an oxygen sensitivity of 0.0002 per cent oxygen, uses an inert gas purification unit, a high frequency induction furnace with a reaction tube, and a conductivity cell. Equipment is reported not to require a glass blower for installation and may be operated by unskilled personnel.

54

Quantovac—Speeding the analysis of a large number of elements in cast metals which could not be analyzed by standard optical emission methods, the *Quantovac* permits analysis of C, P, and S simultaneously with Si, Mn, and other metallics in steel and cast iron. Designed by the *Applied Research Laboratories* for direct reading analysis in the region 1600A-3300A.

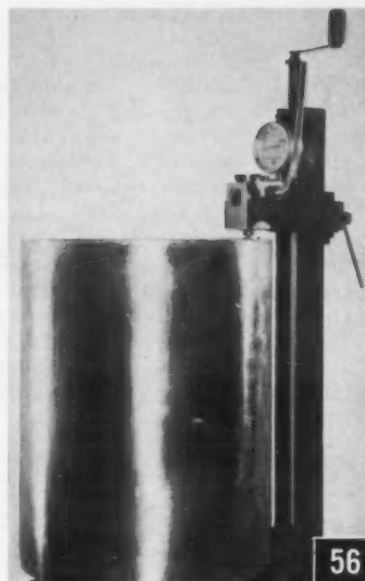
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Hardness tester—A new Brinell tester designed to make hardness tests on castings, cylinders, die blocks, etc. too large for standard testing machines will be displayed by the *King Tester Corp.* The portable (45 lb) machine can be used in any position and has a capacity of 29 in., with a throat of 3-1/2-in. The unit is equipped with rollers for added mobility.

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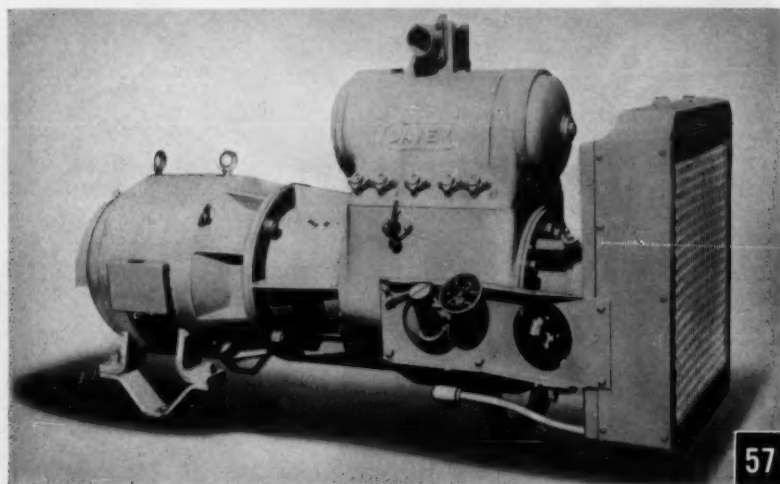
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GENERAL

■ Many of the products and processes of the castings industry do not fall into the preceding nine categories. Some of the other fields covered by exhibitors will be: special casting techniques, equipment, trade associations, publications, engineering firms, consulting services, foundry supply houses, chemical laboratories, and heat treating.

Air compressors—The *Davey Compressor Co.* has announced a new group of stationary compressors available in 20-125 hp sizes, operating at 125 psi. The Davey Hydrovane Rotary compressors are said to feature quietness and freedom from vibration. These lightweight units do not require special foundations ordinarily essential.



57



PATTERN In this case, a sand pattern is shown, mounted on a base. However, patterns of wood, plaster, plastic etc. are readily used. It is noteworthy that this pattern has no side walls and occupies about 10% of the total volume of the casting.

POURING THE SLURRY Pattern is set up and slurry is poured rapidly, completely filling pattern. Approximately 10 to 15, psi pressure is maintained. Slurry fills almost instantly, depending on amount of exothermic heat during stage 10.

STRIPPING Immediately after all, then the sand pattern is removed. At this stage the mold is easily stripped by hand, permitting molding without draft and even slight undercuts. Note the extremely smooth mold face, and reproduction of fine detail.

BURN-OFF & COOLING Mold is removed and slurry is cooled. It is now completely hardened and ready for use. This results in minute casting, as true, it does not exhibit surface finish—had given perfect, self-curing mold, without the thermal shock.

CASTING In the illustration, the mold is mounted on an invertible and furnace, and poured. Any type of gravity pouring may also be used.

AS CAST Castings shown are the "in" condition. Note ability of the sharp corners.

58

There are no exposed belts or couplings; manufacturer reports 50 per cent fewer working parts than other compressors, assuring lower maintenance costs.

57

Shaw Process—Precision casting technique developed in England casts all metals to 80-120 micro-inch surface smoothness using low cost patterns and equipment. According to the *Shaw Process Development Corp., Div. British Industries Corp.*, a highly refractory aggregate and jelling agent is poured over patterns of wood, plaster, aluminum, brass, steel, etc., in the form of slurry. The mix sets to a flexible jelly, facilitating stripping from pattern; mold is then brought to red heat in a furnace, forming a rigid refractory mold ready for use. The finished casting is said to be produced two hours after receipt of the pattern.

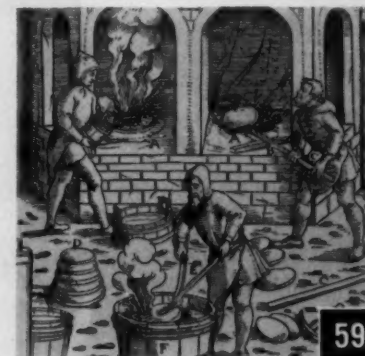
58

Complete foundry operation—*Foundry Equipment Ltd.*, through its *North American Div., F. E. (North America) Ltd.*, will display what the company terms a complete foundry operation with the latest British equipment, most of which is new. The exhibit will not include melting operations. British equipment will include jolt squeeze strip machines, automatic Hydroil electric high pressure undersand frame molding machine, flaskless

mold machine, automatic core blower and rollover stripper, electro vibratory shakeout, and the Con-Belt Mill sand muller designed to handle up to 500 ton of sand per hour.

Foundry methods—500 years ago—*Sipi Metals Corp.*, in cooperation with the John Crerar Library, Chicago, will have on display poster-size reproductions of manuscripts and early books depicting foundry operations such as melting, pouring, and mold-making practiced 500 years ago. The company is foregoing displaying its products in order to make an educational contribution to the Foundry Show. Pictured is an old woodcut illustrating the melting of copper in 1500.

59



59

PREVIEW of Convention Personalities

The 62d Castings Congress and Foundry Show will include the largest gathering of prominent personalities in the castings industry since the 1957 Castings Congress; in addition there will be one of the largest exhibits of new foundry equipment, methods, processes, and services ever grouped under one roof.

Personalities will include national AFS officers and directors, speakers who are experts in their fields,

and many local foundrymen serving on numerous host committees.

The Board of Directors of the American Foundrymen's Society consists of the president, vice-president, the immediate past president (who serves for one year), and 21 other members. Six board members are elected each year at the annual meeting to serve terms of three years each, beginning the day following the close of the annual meeting. One member is ap-

pointed annually by the board to a three-year term.

AFS President H. W. Dietert, Harry W. Dietert Co., Detroit, will yield his gavel to present AFS Vice President, L. H. Durdin, Dixie Bronze Co., Birmingham, Ala. after the May 21st election of new officers and directors. Both Dietert and Durdin are Trustees of the AFS Training and Research Institute, as is past president F. W. Shipley, Caterpillar Tractor Co., Peoria, Ill.

The Nominations Committee, in their December meeting in Chicago, nominated L. H. Durdin as President; present director C. E. Nelson, Magnesium Div., Dow Chemical Co., Midland, Mich., as Vice-President; and six new directors to succeed the six whose terms expire this year.

Directors whose offices terminate in May are C. C. Drake, foundry consultant, Lakewood, Colo.; H. C. Erskine, Aluminum Co. of Amer-

AFS NATIONAL OFFICERS AND DIRECTORS



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C. C. DRAKE



C. E. DRURY



W. D. DUNN



H. C. ERSKINE



R. W. GRISWOLD



H. HEATON

TERMS EXPIRE 1958

C. C. Drake, Foundry Consultant
H. C. Erskine, Aluminum Co. of America
C. W. Gilchrist, Cooper-Bessemer Corp.
O. J. Myers, Reichhold Chemicals, Inc.
C. E. Nelson, Dow Chemical Co.
R. A. Oster, Beloit Vocational and Adult School
R. W. Trimble, Bethlehem Supply Co.

TERMS EXPIRE 1959

C. E. Drury, Central Foundry Div., General Motors Corp.
R. W. Griswold, Erie Malleable Iron Co.
H. Heaton, Mainland Foundry Co., Ltd.
A. V. Martens, Pekin Foundry & Mfg. Co.
A. W. Pirrie, American-Standard Products (Canada) Ltd.
G. R. Rusk, Freeman Supply Co.

TERMS EXPIRE 1960

W. D. Dunn, Oberdorfer Foundries, Inc.
A. A. Hochrein, American Smelting & Refining Co.
K. L. Landgrebe, Jr., Wheland Co.
R. J. Pfarr, Lake City Malleable Co.
J. R. Russo, Russo Foundry Equipment Co.
A. M. Slichter, Felton Steel Casting Co.
H. C. Stenberg, Draper Corp.



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H. W. Dietert Co.



PAST PRESIDENT
F. W. SHIPLEY
Caterpillar Tractor Co.



A. A. HOCHREIN



K. L. LANDGREBE, JR.



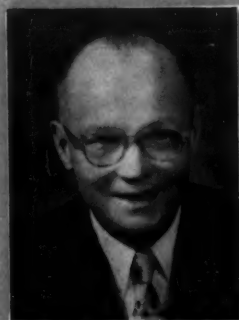
C. E. NELSON



R. A. OSTER



F. J. PFARR



G. P. PHILLIPS



A. W. PIRRIE



G. R. RUSK



A. M. SLICHTER



H. G. STENBERG

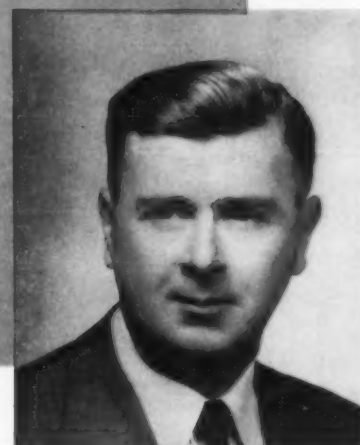


HOYT LECTURER—Walter E. Remmers

A metallurgist who has earned three degrees, the holder of five patents and an impressive list of honorary awards, Walter E. Remmers has written numerous technical papers and has appeared before technical societies. In addition he has spoken to college groups and Chambers of Commerce on the subject of education. He started his employment with Union Carbide Corp. in 1936 and has appeared as president of several of its subsidiaries and divisions. He has been a Union Carbide Corp. vice-president since 1952.

BANQUET SPEAKER—Dr. R. E. Lapp

As one of the pioneers in the development of atomic energy and an advocate of its peace-time uses, Dr. Ralph E. Lapp has become one of the most popular speakers in his field. His experiences with the atom during and after the war combined with his ability to reduce scientific matters to simple terms have been well received at previous AFS meetings. After leaving the government service he established his own scientific consulting service and has devoted much of his time to lectures, writings, and investigations of the effects of radiation fall-out.



ica, Pittsburgh, Pa.; C. W. Gilchrist, Cooper-Bessemer Corp., Mt. Vernon, Ohio; O. J. Myers, Reichhold Chemicals, Inc., White Plains, N.Y.; C. E. Nelson, Magnesium Div., Dow Chemical Co., Midland, Mich.; R. A. Oster, Beloit Vocational & Adult School, Beloit, Wis.; F. W. Shipley, Caterpillar Tractor Co., Peoria, Ill.; and R. W. Trimble, Bethlehem Supply Co., Tulsa, Okla.

Nominated by the Nominations Committee in December to join the board of directors, are D. W. Boyd, Engineering Castings, Inc., Marshall, Mich.; T. W. Curry, Lynchburg Foundry Co., Lynchburg, Va.; R. R. Deas, Jr. Hamilton Foundry & Machine Co., Hamilton, Ohio; Jake Dee, Dee Brass Foundry, Houston, Texas; W. L. Kammerer, Midvale Mining & Manufactur-

ing Co., St. Louis; and H. M. Patton, American Hoist & Derrick Co., St. Paul, Minn.

The Charles Edgar Hoyt Annual Lecture will be delivered by W. E. Remmers, vice president, Union Carbide Corp., N. Y. He will cover silicon and its ramifications in, "*Silicon: Present and Future*." The Annual AFS Banquet, May 21, will feature an address by one of the

nation's authorities on atomic energy, Dr. R. E. Lapp. He will speak about "*Men, Rockets, and Atoms*."

Members of AFS Northeast Ohio Chapter are serving as official hosts for the AFS Convention. The task is coordinated by a General Convention Committee headed by E. J. Romans, executive chairman; F. C. Dost, honorary chairman; and E. C. Jeter, chairman

Northeastern Ohio Chapter

HOSTS to 62d AFS CASTINGS CONGRESS

■ A welcome mat to the city of Cleveland has been arranged for visiting foundrymen by the General Convention Committee of the Northeastern Ohio Chapter.

Heading the General Convention Committee are: Executive Chairman Emil J. Romans, National Malleable & Steel Castings Co.; Chairman E. Claude Jeter, Ford Motor Co.; and Honorary Chairman Frank J. Dost, Sterling Foundry Co. Additional convention committees of the Northeastern Ohio Chapter are on the following pages.



Chairman E. Claude Jeter



Executive Chairman E. J. Romans



Honorary Chairman F. J. Dost

Reception

*Chairman—Lewis T. Crosby,
Sterling Wheelbarrow Co.*

Vice-chairman of the committee is Cleve H. Pomeroy, National Malleable & Steel Castings Co.

Other committee members are: A. D. Barczak, Superior Foundry, Inc.; Frank C. Cech, Max S. Hayes Trade School; David Clark, Forest City Foundries Co.; Frank J. Dost, Sterling Foundry Co.; F. Ray Fleig, Smith Facing & Supply Co.

James G. Goldie, Max S. Hayes Trade School; H. C. Gollmar, Elyria Foundry Div., Chromalloy Corp.; William G. Gude, Penton Publishing Co.; S. E. Kelly, Eberhard Mfg. Co.; Leon F. Miller, Osborn Mfg. Co.

Gilbert J. Nock, Nock Fire Brick Co.; Fred J. Pfarr, Lake City Malleable Co.; Bert G. Parker, Youngstown Foundry & Machine Co.; L.



P. Robinson, retired; Walter L. Seelbach, Superior Foundry, Inc.; Walter E. Sciha, Aluminum Co. of America; Frank J. Steinebach, Penton Publishing Co.

Stewart Tame, National Malleable & Steel Castings Co.; Henry J. Trenkamp, Ohio Foundry Co.; J. H. Tressler, Hickman, Williams & Co.; Stowell C. Wasson, National Malleable & Steel Castings Co.



*Chairman—Robert H. Herrmann,
Penton Publishing Co.*

Other members are Henry Apthorp, East Ohio Gas Co.; and William I. Englehart, MODERN CASTINGS.

Convention publicity in the Cleveland newspapers and on Cleveland radio and TV will be arranged by this group.

Chapter Day

*Chairman—Norman J. Stickney,
Sand Products Corp.*

Other committee members are: F. W. Boemer, James H. Herron Co.; Edward R. Brennan, Forest City Foundries Co.; E. R. Crosby, Smith Facing & Supply Co.; Fred S. Green, Industrial Brown Hoist Corp.

Richard A. Green, Eastern Clay



Products Dept., International Minerals & Chemical Corp.; Donald C. Hartman, Cove Pattern Works; Robert H. Herrmann, Penton Publishing Co.; Howard E. Heyl, Federal Foundry Supply Co.

Charles J. Jelinek, Cleveland Foundry, Ford Motor Co.; Lawrence R. Lansky, Superior Foundry Inc.; W. O. Larson, Jr., W. O. Larson Foundry Co.; George Luekens, Hickman, Williams & Co.; E. A. Macke, Jr., Republic Steel Corp.

William E. Mahoney, Madison Foundry Co.; George Nestor, Jr., National Malleable & Steel Castings

Co.; Robert W. Newyear, Taylor & Boggis Foundry Co.; Gordon L. Paul, Sterling Foundry Co.

Charles D. Pinkerton, Geo. F. Pettinos, Inc.; Lawrence E. Rayel, Archer - Daniels - Midland Co.; J. Doyle Robbins, Osborn Mfg. Co.; James J. Schwalm, Federal Foundry Supply Co.; John E. Sibbison, Jr., Kerchner Marshall & Co.

Walter H. Siebert, Cleveland Standard Pattern Works; Ernest F. Thomas, Ohio Foundry Co.; John F. Wallace, Case Institute of Technology; Harold Wheeler, Allyne-Ryan Foundry Co.

Ladies Entertainment

Chairman—Mrs. E. Claude Jeter

The co-chairman is Mrs. Emil J. Romans. Registration co-chairmen are Mrs. H. E. Heyl and Mrs. H. R. Strater.

The program for the ladies includes a tea, two luncheons, and a trip to the General Electric Co. plant at Nela Park, Ohio. In conducting these activities, the committee will be assisted by a group whose names are listed starting on page 44.



Plant Visitations

*Chairman—A. H. Hinton
Aluminum Co. of America*

Other committee members are: Henry Apthorp, East Ohio Gas Co.; Wayne Johnson, W. C. Best, Inc.; L. N. Schuman, National Malleable & Steel Castings Co.; and W. H. Siebert, Cleveland Standard Pattern Works.

Members of the committee will have a desk in the MODERN CASTINGS booth at the Show which will be headquarters for their activities. Some of Cleveland's outstanding foundries will be open for tours of inspection during the Show and arrangements to visit these plants may be made at the committee's desk.



The committee will also maintain a list of plants open for inspection in addition to the firms listed on page 44.

Shop Course

*Chairman—Frank C. Cech
Max S. Hayes Trade School*

Other committee members include: James G. Goldie, Max S. Hayes Trade School; Donald Gross, Fred Fuller, Inc.; Howard E. Heyl, Federal Foundry Supply Co.; James J. Schwalm, Federal Foundry Supply Co.

John Sharritts, Jr., John A. Sharritts & Co.; Walter H. Siebert, Cleveland Standard Pattern Works.

Banquet

*Chairman—A. D. Barczak
Superior Foundry, Inc.*

The committee vice-chairman is Eugene L. Buchman, Cleveland Foundry, Ford Motor Co.

Other committee members are: Warner B. Bishop, Archer-Daniels-Midland Co.; E. R. Crosby, Smith Facing & Supply Co.; Joseph E. Dvorak, Eberhard Mfg. Co.; Richard A. Green, Eastern Clay Products Dept., International Minerals & Chemical Corp.

Leon F. Miller, Osborn Mfg. Co.; Gilbert J. Nock, Nock Fire Brick Co.; Charles Seelbach, Jr., Forest City Foundries Co.; Walter E. Si-



National Malleable & Steel Castings

ry Div., Berea, Ohio.

Hill Acme Co., 6400 Breakwater Ave. Open 9 am-3 pm. Tour limited to 10 persons at a time. Produce special iron and small to medium gray iron castings.

Plants open Tuesday

Cleveland Standard Pattern Works, 5537 St. Clair Ave. Open 8 am to 8 pm.

Fulton Foundry & Machine Co., Inc., Morgan Ave. at E. 75th St. Open 9-11 am. Special iron and Meehanite castings. Produces permanent mold halves for Alcoa sand shop.

Hill Acme Co., 1201 W. 65th St. Open 9 am-3 pm. Tour limited to 10 persons at a time.

National Malleable & Steel Castings Co., 10600 Quincy Ave. Mechanized malleable iron foundry producing automotive and marine castings.

Plants open Wednesday

Cleveland Standard Pattern Works, 5537 St. Clair Ave. Open 8 am-8 pm.

Fulton Foundry & Machine Co., Inc., Morgan Ave. at E. 75th St.



Fulton Foundry & Machine Co.

Open 9-11 am.

Max S. Hayes Trade School, 4600 Detroit Ave. Cleveland's new vocational training institution.

Hill Acme Co., 6400 Breakwater Ave. Open 9 am-3 pm. Tour limited to 10 persons at a time.

Plants open Thursday

Aluminum Company of America, 2210 Harvard Ave. Mechanized foundry producing a variety of aluminum castings. Visitors other than U. S. citizens may request clearance to tour plant by writing in advance to A. H. Hinton, Aluminum Co. of America.

Cleveland Standard Pattern Works, 5537 St. Clair Ave. Open 8 am-8 pm.

Fulton Foundry & Machine Co., Inc., Morgan Ave. at E. 75th St. Open 9-11 am.

Hill Acme Co., 6400 Breakwater Ave. Open 9 am-3 pm. Tour limited to 10 persons at a time.

Plants open Friday

Cleveland Standard Pattern Works, 5537 St. Clair Ave. Open 8 am-8 pm.



PLANT VISITATIONS

Cleveland is famed as a center of metalcastings production and visitors to the AFS Castings Congress are invited to tour some of Cleveland's outstanding plants. Congress-goers will find some plants open daily during the week, while other firms will be open to visitors only on stated days.

Arrangements to visit plants may be made at the Plant Visitations desk which will be located in the

MODERN CASTINGS booth at the Auditorium. In charge of the desk will be the Plant Visitations Committee, Northeastern Ohio AFS Chapter, A. H. Hinton, chairman.

Plants open Monday

Cleveland Standard Pattern Works, 5537 St. Clair Ave. Open 8 am-8 pm. Produces wood and metal patterns of all sizes.

Ford Motor Co., Cleveland Found-



LADIES PROGRAM

Supplementing the natural lure of the lakefront in spring and the many attractions of Cleveland, Mrs. E. C. Jeter, chairman of the Ladies' Entertainment Committee, and Mrs. E. J. Romans, co-chairman,

have, together with their committee members, planned a full program of entertainment for the enjoyment of distaff members of the Congress.

Registration will be handled by co-chairmen, Mrs. H. E. Heyl and

Mrs. H. R. Strater.
Monday, May 19

A Tea will be held in the Hotel Cleveland.

Tea co-chairmen are: Mrs. E. C. Jeter and Mrs. A. D. Barczak.

Presiding at the table will be: Mrs. A. D. Barczak; Mrs. David Clark, Jr.; Mrs. L. T. Crosby; Mrs. S. E. Kelly; and Mrs. F. J. Pfarr.

Honorary hostesses are: Mrs. F. C. Cech, Mrs. A. C. Denison, Mrs. F. J. Dost, Mrs. F. R. Fleig, Mrs. J. G. Goldie, Mrs. E. C. Gollmar, Mrs. W. G. Gude, Mrs. E. F. Hess, Mrs. R. F. Lincoln, Mrs. G. J. Nock, Mrs. B. G. Parker, Mrs. L. P. Robinson, Mrs. W. E. Sicha, Mrs. F. G. Steinebach, Mrs. H. J. Trenkamp, Mrs. J. H. Tressler, and Mrs. W. L. Woody.

Tuesday, May 20

Luncheon at the Tudor Arms Hotel followed by a visit to General Electric's Lamp Div. plant, Nela Park, Ohio.

Co-chairmen are: Mrs. A. H. Hinton, and Mrs. David Clark, Jr.

The luncheon chairman is Mrs.



Mrs. E. C. Jeter



Mrs. E. J. Romans

Lewis T. Crosby.

Transportation chairman is Mrs. R. H. Herrman. Other committee members are: Mrs. F. S. Greene, Mrs. G. L. Paul, Mrs. J. D. Robbins, Mrs. J. J. Schwalm, and Mrs. J. F. Wallace.

Thursday, May 22

Luncheon and entertainment at Higbee's.

Co-chairmen are: Mrs. E. J. Romans and Mrs. E. R. Brennan.

Other committee members are: Mrs. L. R. Lansky, Mrs. W. O. Larson, Jr., Mrs. W. E. Mahoney, Mrs. W. H. Siebert, Mrs. N. J. Stickney.

day, Malleable, and Pattern; Wednesday, Management; Thursday, Light Metals; Friday, Gray Iron, and Brass & Bronze.

Malleable Luncheon—Tuesday. Lowell D. Ryan, Malleable Founders Society, Cleveland, will speak on "Diversification in the Malleable Industry." The luncheon will be held in the Pine Room, Statler Hotel.

Management Luncheon. R. B. Parker, American Brake Shoe Co., will speak on "Creating a Climate for Management Development," and R. Monsalvateg, Dayton, Ohio, will speak on "Getting the Most Out of Yourself." The luncheon will be in the Ohio Room, Statler Hotel.

Light Metals Luncheon. "Automatic Ladling of Light Metals" will be discussed by the following panel: Robert Haverberg, A-C Spark Plug Div., General Motors Corp., Flint, Mich.; C. H. George,

Western Electric Co., Baltimore, Md.; and Harry Eriksen, Chrysler Corp., Kokomo, Ind. The luncheon will be in the Euclid Room, Statler Hotel.

Gray and Ductile Iron Luncheon. This luncheon audience in the Pine Room, Statler Hotel, will hear H. A. Laforet, Pontiac Motor Div. and F. J. Weffere, Research Staff, General Motors Corp.

Brass & Bronze Luncheon. A panel will discuss "New Developments in Copper-Base Casting Methods." Panel members are: L. J. Pedicini, Congress Die Casting Div., Tamm Corp., Detroit; N. Birch, American Brake Shoe Co., St. Louis; and Nathan Janco, Centrifugal Casting Machine Co., Tulsa, Okla. The luncheon will be held in the Ohio Room, Statler Hotel.

Programs for the Steel Luncheon, Monday, and the Pattern Luncheon, Tuesday, will be announced later.



BANQUETS and LUNCHEONS

■ **Annual Dinner.** "Men, Rockets and Atoms," a speech by Dr. Ralph E. Lapp, authority on atomic energy, will be the feature of the AFS Annual Dinner to be held Wednesday, May 21, at 7:00 pm in the ballroom of the Statler Hotel.

During the dinner AFS Gold Medals will be awarded.

■ **Special dinners.** Three dinners for special groups will be held during the Castings Congress. The Canadian Dinner will be held Tuesday evening at 6:00 pm in the Carter Hotel ballroom.

The Sand Division Dinner will also be held Tuesday evening at the Euclid Room, Statler Hotel. Two speakers will be featured: C. A. Sanders, will discuss "What European Foundries Are Doing," and A. H. Homberger who will describe the automated George



Sand topic: automated Swiss plant.

Fischer Ltd. foundry at Schaffhausen, Switzerland.

The annual dinner meeting of the "official family" of AFS—present and past officers, medalists, honorary life members—will be held Thursday evening.

■ **Luncheons:** Special luncheons will be held by the various AFS divisions and general interest committees. The following have been scheduled: Monday, Steel; Tues-



SHOP COURSES

■ **Six Shop Courses** of practical knowledge for the operating foundryman will be presented at the Castings Congress.

Malleable. Two malleable shop courses will be presented. Monday at 8 pm, Lyle R. Jenkins, Wagner Malleable Iron Co., Decatur, Ill., will describe "Melting Variables and Controls." Tuesday at 4 pm "Supplemental Heat Treating of Pearlitic Malleable" will be discussed by a panel consisting of the following speakers: F. J. Asselin, Chevrolet Motor Div., GMC, Bay City, Mich.; A. Hoover, Oldsmobile Motor Div., GMC, Lansing, Mich.; and A. C. Harris, Cincinnati Milling Machine Co., Cincinnati, Ohio.

Sand. A shop course entitled, "Better Finish—More Accurate Dimensions Through Good Sand Practice" will be presented by a panel of five experts Tuesday at 8

pm. V. M. Rowell will moderate.

Gray Iron. Two shop courses will be presented for gray iron foundrymen. The first, "Basic Microstructures," will be presented by C. F. Walton, Gray Iron Founders' Society, Cleveland, at 8 pm Thursday. The second, "Relation of Mechanical Properties to Microstructures," will be presented by S. C. Massari, AFS, at 2:30 pm Friday.

Brass & Bronze. The shop course for brass and bronze foundrymen will take the form of a seminar on the subject, "What is Expected of a Casting." This presentation will be given Thursday at 2:30 pm by the following panel: W. F. Straight, Bethlehem Steel Co., Quincy, Mass.; J. S. McVey, General Electric Co., Everett, Mass.; and J. W. Foster, Ingersoll-Rand Co., Phillipsburg, New Jersey.



REGISTRATIONS

Registration booths for the Castings Congress and Foundry Show will be maintained in the Lakeside Hall lobby entrance of the Cleveland Public Auditorium. The registration fee for AFS members is \$2.00; \$5.00 for non-members.

Admittance to exhibits and technical sessions is by badge only.

To avoid delay at the registration desks, visitors may complete both registration cards printed on page 99 of February MODERN CASTINGS

and present these at the registration desk.

Tickets to the AFS Annual Banquet and to all official luncheons and dinners may be purchased at the registration center.

Special registration books for Old Timers, international visitors and Canadians will be maintained at the Modern Castings booth, located at the Arena entrance. Registration and arrangements for plant visitations will also be conducted at this booth.



SPECIAL EVENTS

■ **Business Meeting.** President Harry W. Dietert will present the President's Annual Address at the business meeting which will start at 9:00 Wednesday morning in the ballroom of the Public Auditorium.

Election of officers and awards to winners of the Robert E. Kennedy Memorial Apprentice Contest will also be made. Other activities will include the presentation of the AFS Service Citations and AFS Awards of Scientific Merit and the Charles Edgar Hoyt Annual Lecture.

Exhibits will be closed Wednesday morning until 11:00 am.

■ **Apprentice Contest.** First, second, and third place winners in each of the five divisions of the Robert E. Kennedy Memorial Apprentice Contest will be on display during the Convention. In addition, other outstanding examples of

apprentice work will be shown.

■ **Movie Theaters.** Two theaters in the Public Auditorium will be available to exhibitors for the showing of 16 mm films continuously throughout the day. Each exhibitor will be allotted 45 minutes for film presentation and discussion.

■ **International Reception.** This annual reception will be held Monday at 5:30 pm in the Empire Room of the Cleveland Hotel. No admittance will be charged to those attending from outside of the United States and Canada. A \$5.00 admission charge will be made to others.

■ **T&RI Trustees.** A meeting of the Training and Research Institute Trustees will be held at 9:00 am Tuesday in parlor 3, mezzanine, Statler Hotel, Trustees only.

1958

TRANSACTIONS

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by E. G. VOGELp. 59

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by S. Z. URAM, M. C. FLEMINGS, and H. F. TAYLOR.p. 63

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Malleable Iron Microstructures Effect and Cause

REPORT OF AFS MALLEABLE DIVISION CONTROLLED ANNEALING COMMITTEEp. 100

To obtain the greatest benefits from attending the technical sessions of the 62d Castings Congress, bring along your file of the papers that have been pre-printed in MODERN CASTINGS. Keep them handy for reference and discussion.

THE CONTROLLED-SLAG HOT-BLAST CUPOLA

By

D. Fleming*

In the period 1947-1949 the author engaged in a study of reactions in the cupola with a view to arriving at a truer conception of the cupola melting process and a stricter control of cupola melting metallurgy. Particular studies were made of carbon pick-up, the thermodynamics of sulphur removal, the factors influencing silicon and manganese loss and their interrelation with combustion conditions.

By 1950 this work had resulted in the issue of an internal company report defining the principles for a hot-blast, continuous tapping cupola with a water-cooled melting zone and tuyeres and a neutral well. It was proposed to produce gray iron for textile castings from cast iron and steel scrap with ferro-alloy additions and without the use of pig iron. Heretofore, the necessary carbon pick-up and sulphur reduction were obtained by using mildly basic slags of controlled composition.

Up to this time the author had been greatly assisted by the published data of other workers—H. Jungbluth, H. Korchan, P. A. Heller, R. Vogel, F. D. Richardson, J. H. E. Jeffes, C. Heiken, R. Rocca, N. J. Grant, J. Chipman, E. S. Renshaw, and Bamford—together with "THE HANDBOOK OF CUPOLA OPERATION" of the American Foundrymen's Society. Later such workers as S. F. Carter, W. W. Levi, W. Gumz, W. T. Bourke, T. J. Wood, and J. P. Holt were to provide invaluable data. Use had been made of their work by the time that the theoretical considerations were presented to the Institute of British Foundrymen in 1953 in a paper entitled "Inter-relation of Combustion & Metallurgical Reactions in the Cupola".

This paper still forms a reasonable basis for the consideration of the principles of cupola reactions, and it is believed the general conclusions are valid. The author would like to point out however that whereas, in the case of silicon, for instance, he used pure oxide data to show that silicon reduction was theoretically possible, and probable under the correct cupola conditions, the serious worker in the field of slag/metal chemistry must of course allow for the activity coefficients of the reactants concerned, i.e.,

carbon in iron, silicon in slag etc., if valid working data is sought from a theoretical base. Much academic work remains to be done however before the cupola can be said to be fully understood. Workers in this field are also recommended to study later data of H. Jungbluth and K. Stockhamp, A. De Sy, R. Doat, R. Balon, and L. Winandy.

In concluding the above paper the author again defined the use of a cupola with a fully water-cooled melting zone and tuyeres to avoid slag contamination; with continuous syphon box tapping to ensure reasonable constancy of slag depth; and with a neutral well using a graphitic material, coupled with a blast temperature as high as the economic and practical factors of present recuperator design would allow, to give high reaction temperatures with reasonable coke consumption. The latter however were entirely subordinate to the metallurgical performance of the plant.

The economics were based on the metallurgical ability to use scrap and ferro-alloy charges, without pig iron, for the production of a refined gray iron at least equal to that produced by more orthodox methods. The pronounced differential between pig iron prices and those for cast iron and/or steel scrap plus ferro-alloys, gave all the incentive required in the United Kingdom.

Between 1950 and 1953 however, on the practical side, a small pilot plant had been designed to obtain confirmatory data. This in turn had been abandoned as faith in the process had overtaken the need for it, and two full scale production plants were in an advanced stage of design. The first of these was erected in the foundry of Dobson & Barlow Ltd., where the presence of existing orthodox plant would allow for a period of "teething troubles". This plant had its first melt in March 1955. The sister plant was erected as the sole melting plant in a new foundry of Platt

Note: Officially sponsored paper to AFS from The Institute of British Foundrymen.

* Foundry consultant to Textile Machinery Makers Ltd., Oldham, England.

Bros. (Barton) Ltd., and went into production in June 1955. It is with the design factors arising out of the experiences gained in the process of putting theory into practice that the author is mainly concerned in this paper.

THE HOT BLAST SYSTEM

Metallurgically, one is only concerned with the provision of an accurately controlled quantity of blast at the required temperature and pressure, which can be supplied via an independent heater or a recuperative system with, at first sight, no regard for anything other than the direct economics of first cost, and the relative running costs of each. There are some other factors which may influence this choice when the proposed plant is to run with very high reaction temperatures and medium or high coke percentages.

The top gas from such a plant will be rich in CO, say 20 per cent or so. A large volume of such a combustible gas at the charging opening of a cupola presents a problem in itself. If it is allowed to burn at the cupola the problem of heat dissipation, and grit and dust control, without extensive, and therefore expensive, precautions, becomes almost prohibitive. If it is first drawn from the cupola and cleaned, unless once again it is burnt, it constitutes a possible poison hazard. Thus a system which draws off this gas, removes the bulk of the solids from it, and burns it before discharge, while simultaneously supplying the heat for blast heating, has something to recommend it when clean air conditions are also to be considered.

In addition to such considerations the cost of fuels such as gas or oil, in the United Kingdom, are such that a considerable running cost can accrue with separate heaters. So the decision to use a recuperative system was made.

Continued study of the various systems in use on the continent of Europe, where a considerable volume of operating experience had been accumulated, showed that, with the advent of percussion air lance cleaning methods, the major problem of recuperative plants, i.e., dust removal, had been reduced to quite manageable terms with cast tube recuperators in which the air flow was through the tubes and the gas flow outside the latter. This innovation removed a previous leaning to steel tube recuperators with gas flow through the tubes and flue brush cleaning.

This position was further influenced by the fact that if the shot cleaning system being tried experimentally on cast element recuperators was as successful as it had previously been in boiler practice, then a decided advantage would rest with this type of recuperator with the dirty gas on the outside of the exchanger elements. This prediction has now been realized, and continuous cleaning during operation is now possible with this type of recuperator. A four-bank cast element recuperator was therefore chosen, with provision for the later addition of shot cleaning.

In the most perfect recuperative hot-blast systems in use with cupolas it has not proved possible to remove the very finest dust particles prior to the recuperator without losing the sensible heat of the top gas. Where this total cleaning must be done to comply

with very strict clean-air regulations, it is the author's opinion that it should be performed by washing of the final cooler and inert exhaust gas. Meanwhile the very presence of this fine dust imposes a further condition on the design of recuperative plants.

The cleaning system should, desirably, only be asked to remove this dust as such, and that the peak temperatures, at the hot gas inlet of the recuperator, should not be allowed to exceed a temperature somewhat below the "fritting point" of this dust, except in the case of certain specially designed "superheater" units, used in cascade with normal recuperators, when blast temperatures of 600-800 C (1112-1472 F) are required.

The blast temperature specified for the plants under consideration was 500 C (932 F) at the wind belt so that a superheater was not fitted. It was accepted that this limitation to recuperator inlet temperature was a factor of great importance for trouble-free operation, as also was steady, well controlled, blast temperature for the maintenance of uniform metallurgical conditions. For any given blast temperature and volume a quantity of heat is required from the top gas. This factor can be controlled by the manipulation of a damper in the outlet from the exhaust fan which draws gas from the cupola via the gas offtakes, the gas damper and dust arrester, the combustion chamber where combustion air is added, and then through the recuperator.

Such a simple system alone however does not prevent the products of combustion exceeding the fritting temperature of the dust, and perhaps even the safe temperature for the first bank of recuperator tubes. Some systems use additions of excess air to control this condition when necessary, but, if combustion was not initially complete there is some danger that the first effect will be to complete combustion, and thus lift the temperature. Careful operation, to insure that excess air is always present, gives a prior complication.

RECUPERATOR INSTALLATION

The author much prefers the system in which already burnt gas, which has been cooled by passage through the recuperator, is recycled from the outlet side of the exhaust fan to the hot burnt gas main from the combustion chamber to the recuperator. A system of multiple inlets, and adequate length main, is allowed to insure uniform mixing, and hence freedom from local hot spots, prior to the actual point of entry to the recuperator. This system has the advantage of simplicity, being easily controlled by a damper in the recycling main or loop. As cooled, but by no means cold, inert gas is recycled, no combustion problems arise, and the effect is smooth in operation. The short circuiting effect of the loop also simultaneously lowers the top gas demand rate at the combustion chamber by lowering the effective exhaust fan suction, and thus producing a completely coordinated effect.

This system was therefore chosen. Further details of this type of plant may be obtained by reference to the work of E. Loebbecke. The blast temperature/recuperator inlet temperature control system was completed, in the case of the plants concerned, by using

a thermocouple to measure the blast temperature from the recuperator, and also one to measure the recuperator inlet temperature. Each of these outputs is taken to its own amplifier. The output of the latter is used to stabilize the heat input to the recuperator via a hydraulic controller which operates on the bypass valve, subsequently altering the main exhaust damper through a second hydraulic controller should the range of the first control prove insufficient.

The output from the blast temperature amplifier is also recorded and passed to a three-term hot-blast temperature controller. This latter controller is in cascade with the recuperator inlet temperature controller. The desired value of recuperator inlet temperature is adjusted automatically to maintain a constant hot blast temperature.

Provision is made in the automatic control equipment to limit the maximum recuperator inlet temperature. Setting dials are housed in a lockable glass-fronted case on the main control panel which allow this maximum to be "pre-set" and also the desired hot-blast temperature. Visible alarms show if either of these temperatures are incorrect. A klaxon alarm operates should the recuperator inlet temperature rise above the chosen limit. Warning lights also operate should there be a failure of either hot-blast temperature or recuperator inlet temperature thermocouple. To complete the top gas control system a surplus gas ejector is used, using air from a separate fan via a controlled damper to vary the suction effect at the ejector cones. Thus, when the top gas demand to the combustion chamber falls, it will be indicated by a less negative combustion chamber pressure.

A pressure element linked to the latter increases the air supply to the ejector, via a further hydraulic controller, so that the gas is still drawn from the cupola via the top gas main. After passing through the normal dust catchers, gas is removed prior to the combustion chamber, via a further dust trap and the ejector. This serves to prevent dust emission from the cupola at all times other than "blowdown", and to maintain steadier combustion chamber pressures. If at a later date it should be decided to use this surplus gas for other heating purposes a tap-off point exists and the controller will then simply be switched to control a suction damper at the exhaust end of such a system instead of the suction of the present ejector.

It is not desired to labor the auxiliary detail of the plants. The Dobson & Barlow plant has been well described by Henderson, who was for some time foundry manager at this plant, and to whose metallurgical staff the present author handed it over for production operation, after its installation and teething troubles had been overcome, prior to the start of the second plant at the Barton factory of Platt Bros., where research was continued for a further period.

Some of the author's works photographs and data have also been published by E. Loebbecke in a paper presented to the AFS. It must be recorded however that the plants were, as pilot production plants, equipped with an all-embracing system of instrumentation. Everything that could be done to insure regularity outside the cupola proper was, as far as possible, built in to the system. All salient data such as charge weights, blast volume, blast pressure, metal tempera-

ture, the hot-blast equipment temperatures, etc., were dealt with by recorders.

THE CUPOLA PROPER

It still remains a simple truth however that, no matter how much is done outside the cupola proper to serve it with accurate charges, with a precise quantity of air at a given temperature, with a known safeguarded supply of cooling water, etc., the question as to whether the correct, or anticipated, results are obtained rests still, not only with the know-how of the operator but, in a large measure, on the design of the cupola itself, especially with that portion between the base plate, or well bottom, and the upper limit of the reaction zone. All else is done to serve this few feet of cupola. Here lies the heart of the whole process of cupola melting.

The author therefore proposes to deal in some detail with the original design of this area, the initial results achieved, the reasoning applied, the changes made, the consequences of these changes and the lessons for the future he believes they hold for this type of plant.

Figure 1 shows the section of the cupola proper as originally installed. The upper portion of the shaft (a) was orthodox and lined with normal acid brick work to a point 15 ft 11 in. above the cooled shell. The further remaining 3 ft to the charging sill was lined with iron brick. Three stack gas offtake open-

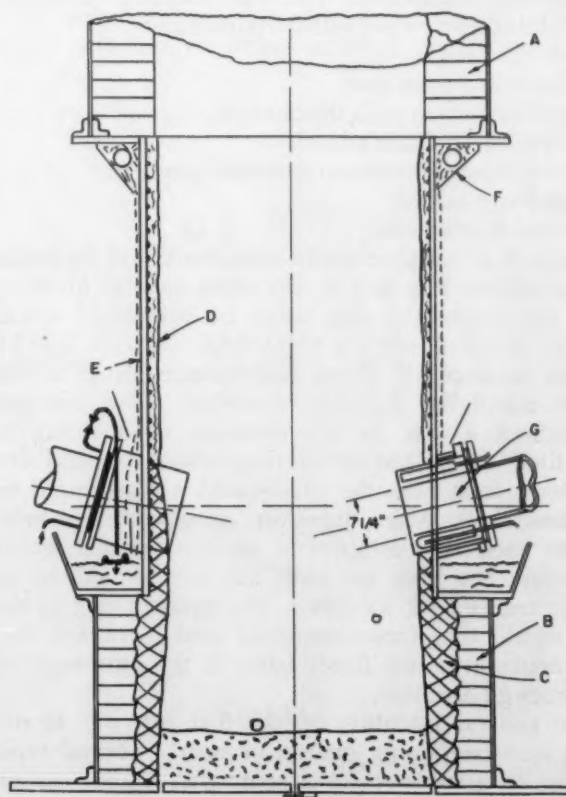


Fig. 1—Section of the cupola proper as originally installed.

ings were disposed around the upper shaft. The lower edge of their steeply rising throats were 7 ft 10 in. above the top of the cooled shell. Their vertical extent, some 3 ft 6 in., gave a column of stock some 7 ft 7 in. above the offtake tops with the cupola

charged to sill level. This gave adequate back pressure, and hence no danger of air intake during normal charge level fluctuations.

The well was lined with normal acid firebrick (b) for some 6 in. from the shell. Where openings were required for tap-holes, "back door", etc., this acid material was kept well clear of the actual finished opening size. The well lining proper (c) was rammed-up with an acid ganister (graded silica and fireclay) into which had been milled some 25 per cent plum-bago. This produced a refractory which was neutral to slags with a basicity range up to 1.5 CaO/SiO₂. The usefulness of this material being much enhanced by high ramming density, an air hammer was used during the placement wherever possible.

TEST RUNS

The tap hole, front slagging box, and other openings, were all formed in this material. From a point just below tuyere center line, the cooled shell proper (e) was formed from 7/8-in. steelplate with 1/2 x 1/2-in. diameter steel studs covering the inner surface at some 2-in. centers, shell was lined with a 2-3 in. layer of acid ganister (d). Six copper water-cooled tuyeres (g) were fitted, each with an internal diameter of 7-1/4 in. giving a tuyere ratio of 5-1/3:1.

It was believed that with an established internal condition in the cupola, i.e., with no lining loss to interfere, it would prove possible to calculate equilibrium slag sufficiently close for practical purposes. The total silica content was derived from:

- 1) the coke ash,
- 2) silicon loss from melt,
- 3) sand carried in with the charges,
- 4) any silica in fluxes added.

The total lime content was derived from:

- 1) the fluxes added,
- 2) traces in coke ash.

Thus, if a fairly accurate estimate could be made of the silicon loss and of the silica carried in along with the charges, a slag could be calculated which should be basic with a CaO/SiO₂ ratio of 1.2/1.0 in the absence of lining interference. Now if the fluxes calculated for this condition were charged throughout a run, in the presence of a lining as described above, the initial slags would be acid due to interference from the excess acid ganister used on the steel shell. When, however, an equilibrium layer on the shell was established no interference would exist, and the slag reaching the well would be as calculated, i.e., 1.2/1.0 basic. The average slag in the well would therefore commence acid, approach and pass neutrality, and finish basic if the run were of long enough duration.

The general intention on the first run was to use a pig iron containing charge of nearly normal type, making an allowance for a somewhat higher carbon pick-up which was expected due to the effect of the higher blast temperature, coupled with a coke ratio of 1:8. It was hoped that silicon correction could be made in the ladles should silicon loss become excessive later in the run and steps be needed to restore the carbon equivalent value which, perhaps fortunately, was required to be 4.3-4.4.

Preheating of the bed and well was to be most

carefully done, and the bed height set a few inches lower than for standard cold-blast practice. Normal limestone additions were made to the bed prior to charging.

The blast was to be put on at an initial temperature of at least 300 C (572 F), using the combustion chamber oil burners to insure this. Blast temperature was then to be run up on top-gas heating, but not necessarily fully up to 500 C (932 F) on this first occasion. Metal analysis was to be done on close interval samples, the results being transmitted immediately back to the plant, where they were to be logged on a large blackboard.

A rear emergency slag-hole was to be left open, to indicate metal level, prior to tapping through the preheated slagging system, thus ensuring that a premature tap would not be attempted.

In fact, when the moment came to make this first tap, troubles of quite an unexpected order arose. The tap hole froze; oxygen lancing had to be used; and a start was only made with difficulty. Metal temperatures were lower than expected and the run was terminated after some 2-1/2 hr, having run as an acid run throughout.

It was discovered on investigation that a normal cold-blast bed height had in fact been used. It was thought that this factor, coupled with lowered blast temperature accounted for the poor start, and that it would also be desirable to lift the charge coke from a 1:8 to a 1:7 ratio. Further, as the lining had been largely preformed, the carbon content of the charges for the second run was lowered by substituting 5 per cent steel scrap in place of 5 per cent pig iron to allow for the effect of the extra fuel and probable basic conditions. Unfortunately, on the second run also a lance was needed to open up the tap hole. Though somewhat improved, metal temperatures were variable, and difficulty arose in consistently pouring at the desired temperatures.

To counter this rather dismal picture however, the story told by the metal analysis, observation of slag samples, etc., was gratifying. The furnace had quickly turned over to mildly basic running, with a falling average sulphur, and a lower silicon content in the metal. In view of these results being obtained early in the run it was decided to (a) increase the charge silicon content and (b) decrease the limestone addition. The further results were, a jump in silicon content followed by a tendency for a further rise, as the furnace returned to acid running again, coupled with a rising tendency in the sulphur figures. The results obtained in this original run are shown graphically in Fig. 2. Obviously the task now was to establish true control of the new process. Once again this meant that control of metal temperature was imperative.

FURTHER RESULTS

Following runs in this early period showed that, although bed height changes indicated an optimum height, even when this level was used, the results were below expectation. Trials were then made using different blast temperatures at the initial blast-on stage. These were supplemented by using different thicknesses of cold coke between the preheated bed level and the first charge so as to prevent premature slow

melting. Thus, the first tap position was rescued from the previous initial certainty of a hard tap, but a perplexing condition remained in the subsequent temperature behavior:

- The temperature could apparently run at one of two levels, remaining in the upper or lower, either for long or short periods at a time, in an apparently random manner.
- Recovery after shut-down periods was very often slow and showed a distinctive temperature arrest, even when eventually the rise continued to the higher level.

Furthermore the extended experience being gained

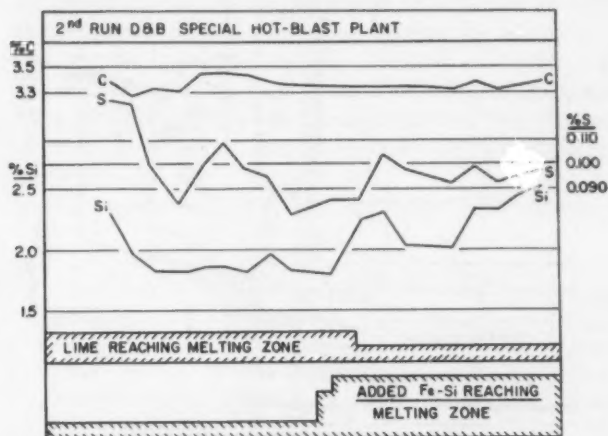


Fig. 2—Change in metal analysis brought about by charging more silicon and less limestone.

showed that while at lower temperatures silicon losses followed the trend of both metal temperature and slag basicity, at sufficiently high temperatures the temperature effect could be made to predominate.

Figure 3 shows a record where the slag was being made slowly more basic during the morning period with higher volumes of slag, followed by an afternoon period with a low volume of slag of a nominally

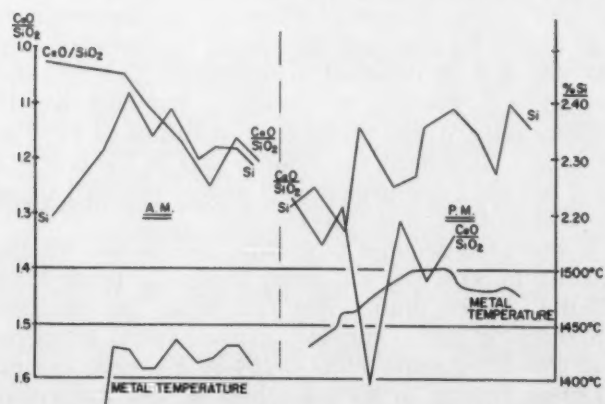


Fig. 3—Trend toward more basic slag during one day's cupola run. Silicon in metal increases.

constant basicity. This record illustrates several of the points to which reference has been made.

- During the morning period average silicon level fell as the slag went more basic.
- Deviations in the silicon level were also linked with deviations in temperature, whether by direct effect or from some common cause.

- The afternoon furnace behavior was quite different, a completely different temperature level being achieved, not explicable purely on the basis of a lower slagging rate.
- Under these conditions lower silicon loss, i.e., a lower silica quantity in the low slag volume, actually results in an increased basicity, while the general silicon level is climbing, in line with an increasing temperature.

This record, like many other observations made, showed that, at any chosen operating level of basicity, it was most important:

- to keep the metal temperature high to minimize silicon loss for both metallurgical and economic reasons,
- to keep this temperature as steady as possible to insure steady silicon figures,
- that the quantity of slag kept in the well should be adequate to prevent rapid basicity changes following metal silicon losses.

THE QUEST FOR TEMPERATURE CONTROL

Temperature control became the foremost interest therefore from every point of view. A rough heat balance showed that over 3×10^6 Btu per hr were being lost into the cooling water. But of course a considerable loss was an expected part of the process. Further high metal temperatures were sometimes achieved, and sometimes not. Linings were reformed, by the original process, to try and establish a thicker stable layer of insulation. Such a result was not obtained, but data on lining contours proved to be in-

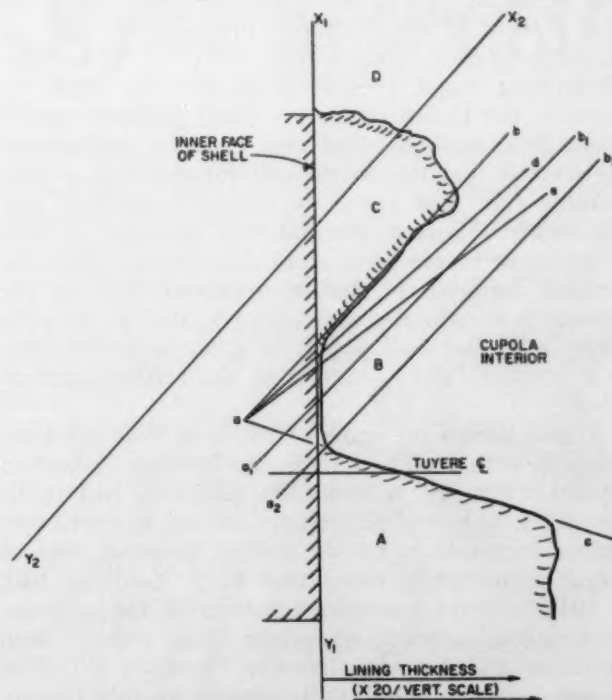


Fig. 4—Contour of cupola refractory lining does not remain uniform during melting.

formative. Such a contour is shown in Fig. 4 with the horizontal scale purposely much exaggerated.

A study of this contour shows that in the zone A, i.e., at a level crossing the tuyere entry and below,

an adequate lining remains. Immediately above however, the lining is a very thin shell of slag only, in zone B. Whereas above this again, in zone C, a gradual increase in lining thickness occurs to near the top of the cooled shell, when the diameter reverts to the brick lining diameter in zone D. The first theory was developed from this contour on the following lines:

- 1) It was noted that if the slopes "a-c" were continued to point "a", this lay outside the shell.
- 2) It was concluded that if the field of combustion could be pushed further away from the shell, so that point "a" lay within the shell, an adequate lining would remain and the cooling losses would fall.
- 3) Therefore the cooling losses were higher the nearer melting was to the shell.

From this line of reasoning it was a short step to a possible explanation of the events occurring. Surely temperature was high when the main melting was occurring towards the center of the cupola, and low when the melting was too near the perimeter. This condition was a random function of the particular burden density distribution obtaining at a given period. If too great a proportion of the melting was occurring near the shell perimeter, this also explained the poor recovery after a shutdown, as the cooling would be affecting the main melting and superheating zones during such a period. Obviously, with a fully cooled cupola, the cupola must be forced to be "center going" at all times.

Reverting to Fig. 4, it was felt that a considerable improvement would be made if the tuyere projection was increased. It was hoped the contour of the lower face of zone C would change progressively with increasing tuyere projection from "a¹-b¹" to "a²-b²" thus eliminating major cooling losses via the shell. To increase the tuyere projection alone however would result in a much reduced area between the tuyeres. It was felt that this might call for too high a coke burning rate, and adversely affect the melting rate obtainable. Thus, a simultaneous increase in shell diameter at tuyere level seemed necessary. This also seemed desirable in that it appeared that, as the furnace was naturally developing a contour with the slope "a-b", the shell should be given a similar slope in a position "x²-y²," instead of the existing vertical "x¹-y¹."

A new design for cooled shells had thus been developed, with a conical shape, and deeply projecting tuyeres, (Fig. 5). A limitation obviously had to be put on the degree of projection however, to avoid very serious increases in tuyere cooling losses. It was of course immediately noted that E. S. Renshaw had, in 1944, advised a similar construction for even refractory-lined cupolas, to reduce lining erosion, and, had later added cooling panels. Therefore a feeling of satisfaction existed with regard to this design, coupled with high hopes of eventual success, and a renewed admiration for the work of E. S. Renshaw.

However such an approach to the problem required a considerable delay for new construction work, and meanwhile the problem was urgent. A second approach which could be immediately tried was therefore also proposed. This was to attempt to move the

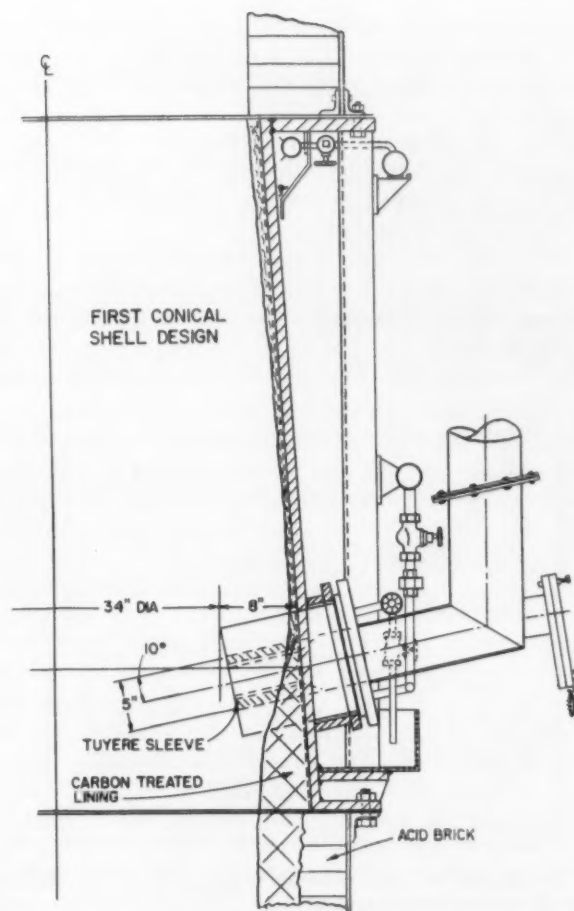


Fig. 5—New cupola design used conical shell and projecting tuyeres.

combustion to the cupola center, not by ducting the air there with extended tuyeres, but by giving it a high initial velocity at the tuyere nose.

A graph was drawn showing the velocity variation per tuyere against total indicated volume for the 7-1/4-in. tuyeres, as fitted, and for sleeves of 6.5, 4.375, 4.0 and 3.0-in. diameter. Allowing for correction to true blown volume, and expressing the velocity as if the air was at standard temperature and pressure through the tuyeres, to obtain a standard weight velocity ratio, it was found that, at the usual rates of blowing at that date, the velocity was of the order of 25 ft per sec (approximately 8 meters per sec) using the standard 7-1/4 in. tuyeres.

It was then decided to fit 5-in. sleeves and lift the velocity to 50 ft per sec, using a slightly lower blast volume. A new lining was run in in this manner. On reaching stable running, general metal temperature was lifted some 30-50 C (54-90 F), even though no great change in the total heat in the water was then noticed. A check on the lining contour however indicated a change from the original slope "a-b" of Fig. 4 to a sharper slope as shown by the dotted line "a-d." This indicated that a shortened combustion zone had also been achieved. This conclusion was further emphasised by the fact that the temperature of the top gas leaving the cupola had also fallen from 450-600 C (842-1112 F) to a level of 400-530 C (530-986 F).

These results were most encouraging and further

work was done using smaller sleeves and higher velocities through the tuyeres. Each successive increase in velocity was, of course, accompanied by an increase in wind belt pressure for equal volumes of air. As the successive increases eventually gave little further advantage it was decided that for this particular furnace 3-in. sleeves suited the lower melting speeds and 4-in. sleeves the upper range, i.e., a tuyere velocity of some 85-115 ft per sec, (approximate mean of 30 meters per sec), based on the true theoretical air requirement at S.T.P.

Figures for a run at the lower end of this range (85 ft per sec) show the still further increase in metal temperature obtained, i.e., a rise into the 1540-1580 C range (2800-2875 F) and the further lowering of the top gas temperature to the 250-300 C range (480-570 F), see Fig. 6. This behavior being accompanied by a still further change of slope in the lining contour to "a-e," showed that the combustion and reaction zone had been still further shortened.

This work removed the difficulties previously ex-

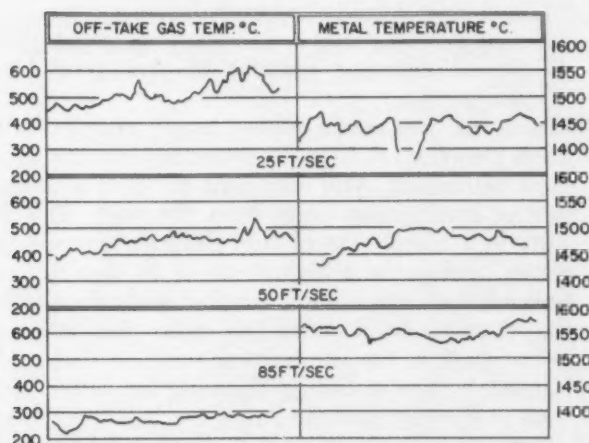


Fig. 6—Effect of blast velocity on metal temperature and off-take gas temperature.

perienced by lifting the metal temperature to a metallurgically satisfactory level; where silicon loss was only of the order of 10 per cent with slag of some 1.25 CaO: SiO₂ ratio; where adequate casting temperatures could be consistently maintained; and where temperature recovery was rapid after shutoff periods; and cold taps were a matter of history. This plant has been run on these principles during the succeeding years. During this time, when using 16 per cent coke instead of the standard 14.4 per cent which is normally used, as in the experiments above, temperatures up to 1600 C (2922 F) have been recorded at the tapping box, by immersion thermocouple.

The theory of the conical shell was not neglected however. Such a shell was made and fitted to the second plant (Fig. 5). Again ranges of tuyere velocities up to some 100 ft per sec were used, with the conclusion that such velocities are desirable, and similarly advantageous on this type of furnace, and for the size of furnace used. With the knowledge of the important role played by tuyere velocity, no troubles were experienced with this plant, which has given excellent temperature and metallurgical behavior since start-up.

This type of design moreover has certain advantages:

- 1) The provision of an adequate water curtain on the shell surface is much simplified.
- 2) Total blast pressure per unit volume of blast is reduced, easing blower and recuperator conditions.
- 3) The total heat loss is somewhat reduced.
- 4) The furnace appears to be smooth in operation and responds well to calculated changes in conditions.

REVISED THEORY

The heat loss to the cooling water in such a furnace remained quite high however. Even under optimum conditions it was, for our rating of furnace, not reduced below some 66 per cent of the original losses, in respect of the loss via the shell. Further, even with tuyere projection, increased and higher tuyere air velocity, the slag coating on the inside of the shell over the remaining shortened combustion zone was extremely thin.

A review of the situation was therefore made leading to a number of conclusions on the behavior of slag-lined cupolas:

I. If a reversion is made to the original contour diagram of Fig. 4 and, based on the thickness of scale, steel, and internal refractory, a graph is drawn showing the rate of heat transmission per degree F temperature differential, then a curve of the type shown in Fig. 7 results. From this it can be seen that, with equal temperature differential, practically the whole of the heat loss occurs through the small band of very thin refractory at the combustion zone of the cupola.

II. It is now regarded as fundamental that, if the slag present in the cupola to form a lining face is of

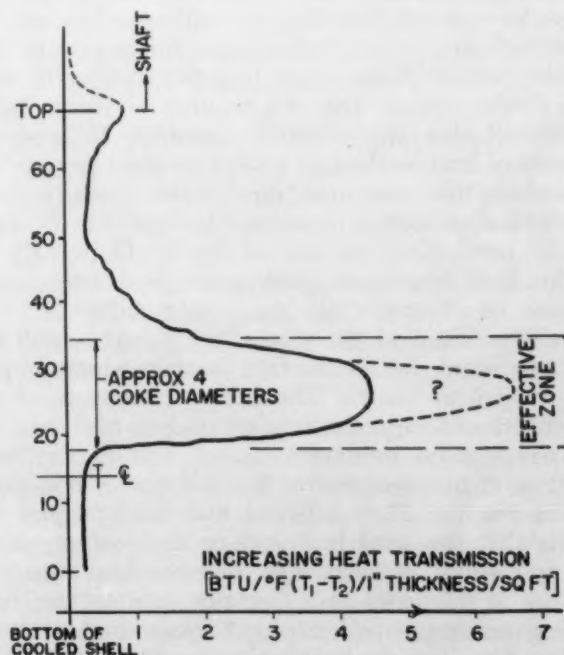


Fig. 7—Practically all the heat loss occurs where lining is thin at the combustion zone.

constant composition over the depth of the cooled zone, then the inner face temperature of the slag lining must in fact be constant over the depth of the

cooler. It would in fact correspond to the flow temperature of such slag as (a) were the refractory face below this temperature, further slag would freeze on to this inner face, or (b) were the refractory face above this temperature refractory would be slagged or melted off until such a balance was obtained.

III. Only changes in composition of the slags present over the depth of the cooler can therefore alter the inner face temperatures.

IV. Only that slag on the inner face at the combustion zone has a predominant effect. This is the zone where maximum iron oxide is likely to be present with its violent depressing effect on slag melting temperatures. So the only factor of serious importance is the removal of this face as far as possible from high metallic oxide concentrations.

V. Under constant internal furnace conditions, and thus with a slag of a definite composition, and hence constant melting point, present at the inner face of the refractory of the combustion zone, a constant differential temperature will exist between this inner face and the water. Thus the loss per square inch of surface here will remain constant.

VI. Attempts to alter this rate by altering the temperature of the outside cooling medium will fail as any procedure which lowers the heat transfer rate will raise the inner face temperature, for a constant rate of heat arrival internally, with the constant internal furnace conditions specified. Thus the slag layer inner face will exceed its own melting or flow point, and will simply reduce in thickness until the rate of heat transfer is restored, and the inner face is again stable at the slag flow temperature.

VII. If two furnaces of different diameter are now considered, but in each case the fuel is sized to a constant ratio of that diameter, e.g., 8 per cent, then it can be expected that the combustion and reduction zones will be deeper in the larger furnace or in the smaller furnace if the larger fuel was used, as to obtain similar surface area the number of pieces traversed will stay approximately constant. If however the rate of heat production is kept constant per square inch of melting zone area, then, if the depth of zone in which this heat is developed is doubled, the rate of heat production per unit of depth will be halved.

Thus for a deeper combustion zone, and hence deeper zone of affected shell, the heat quantity arriving per unit width over the total affected length, will remain constant for a constant heat production per square inch of hearth. The full picture of the heat transfer would require a detailed analysis of the differing temperature gradients caused, and of the new fractions of heat transmitted by radiation, conduction, and convection. It is believed that the practical result is that the total heat lost to the cooling water per unit width of shell, also, like the heat quantity arriving at the inner face, remains constant for furnaces running at equal rates per square inch of cross section. Therefore the heat loss varies with the circumference of the shell.

VIII. For furnaces running at different rates of heat production per square inch of cross section, the rate of heat arrival per unit width of shell in the combustion-reduction zone will vary. It is postulated that, once again, the slag layer alters in thickness so as to

always have a constant inner face temperature. So higher driving rates give higher losses per unit width of furnace circumference, and similarly lower driving rates give lower losses per unit width.

IX. To remove the slag on the cooler face from the effects of iron oxide in the critical combustion zone section it is desirable to:

- a) slope this face away as in the conical shell to lower the physical probability of impingement by oxide-rich slag formed in this zone.
- b) insure, if possible, that the path of air travelling from the tuyere noses towards the shell is sufficiently long to remove free oxygen prior to its arrival at the shell. Use tuyeres projecting in from the shell. A distance of some 2-1/4 coke diameters is felt necessary with blast at 500 C (932 F), though it is feared that wall effect will always allow the transit of some free oxygen to the shell in this region no matter what steps are taken.
- c) shorten the free oxygen zones as much as possible. By all means promote metal temperature with:
 - 1) high blast temperature.
 - 2) high blast velocity and turbulence.
 - 3) correct coke sizing to prevent poor penetration.
 - 4) correct charging practice to give good blast penetration.
- d) charge to give center-placed metal, coupled with good penetration from inserted tuyeres and high blast velocities. Also combine to give a higher rate of combustion away from the shell. This results in a faster rate of fuel descent towards the center, and hence a higher rate of burden descent towards the center. This, coupled with the conical shape, promotes a metal-free coke ring adjacent to the shell in the combustion zone, so that oxide formed by metal falling through the latter zone is created away from the lining.

X. Some perplexity has arisen in the definition of size in relation to melting rate in the case of conical shell slag-lined cupolas. However in the light of the comments above, if for standard conditions:

- 1) it is considered that the optimum coke size is always 8 per cent of the cupola diameter,
- 2) that a tuyere projection of 2-1/4 coke diameters is required with 500 C (932 F) standard blast temperature,
- 3) that the half diameter of the pieces of coke nearest to the shell take no part in the active melting zone, then certain fixed relationships will always exist:

- a) The tuyere projection for each tuyere will always be 18 per cent of the shell diameter.
- b) The active melting zone will always be 8 per cent less in diameter than the shell diameter above the tuyere top face level. Thus the active melting zone will always be 84.64 per cent in area of the area measured above tuyere top face (maximum diameter inside lining).

Thus it becomes of only academic interest with such a fixed design relationship, whether the melting rate is defined in relationship to the diameter at the top tuyere face level, i.e., maximum shell diameter, or to the 84.64 per cent active area, or even to the area between tuyeres, as these will always be in a fixed ratio. For simplicity therefore we have used

the maximum area in the zone of maximum shell diameter above the tuyere top face level. Under these conditions, the standard design figure for the determination of the normal maximum melting rate, using normal coke fuel of some 88-90 per cent fixed carbon, in ratios of 14-16 per cent, which are again considered normal with 500 C blast temperatures in such cupolas, is considered to be 11-12 lb of iron per sq in. per hr, (7.6-8.3 long tons per sq meter), which would be approximately 13-14.2 lb per sq in. per hr (9-10 tons per sq meter) if calculated on the basis of the 84.64 per cent active melting zone.

At a melting rate of some 11 lb per sq in. per hr, the heat loss to the cooling water via the shell will vary from some 20,000 Btu per in. of shell circumference, down to some 13,600 Btu per in., according to the excellence of the design. The latter lower figures are achievable with the conical shell design described above, coupled with optimum tuyere velocity and coke ratio.

As described above, the shell heat loss per inch varies with the rate at which the furnace is operated. Figure 8 shows the way in which this heat loss changes. Lower and upper limits are used. The lower indi-

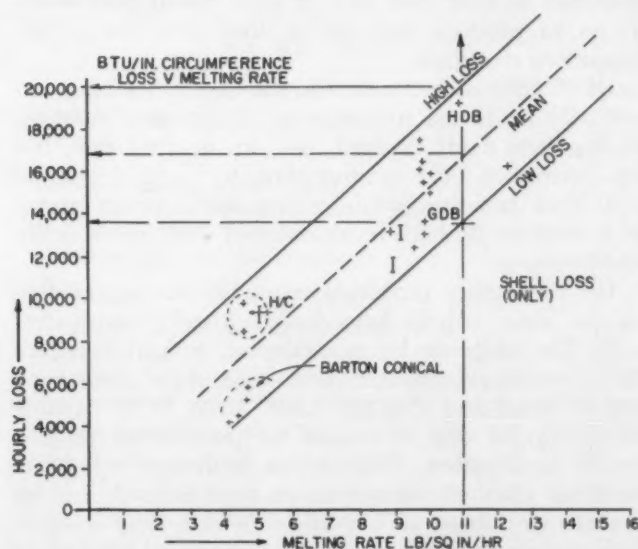


Fig. 8—Influence of melting rate on heat loss.

cate results believed obtainable with optimum conditions. Upper limit should be clearly covered when ascertaining the capacity of cooling pumps, pipework, etc.

The subject of heat losses via tuyere cooling is not yet so well defined. Figure 9 shows the upper limit

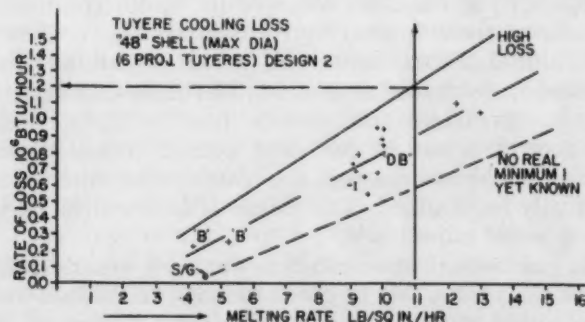


Fig. 9—Tuyere cooling also accounts for lost heat.

of a band showing loss variation versus melting rate per square inch for a 48-in. cupola equipped with 6 projecting tuyeres. Again, for similar designs, it is felt that increasing these losses in ratio to the furnace diameter will give a design guide. Obviously there is more scope for change due to good or poor design, and no lower limit has been set. Certain factors are again obviously desirable, such as keeping the outside or exposed surface area of the tuyere at the absolute minimum compatible with safe cooling. This is obviously assisted by the use of high tuyere velocities, as thus the tuyeres will have smaller external diameters.

A further factor can also be exploited. That is the covering of a fair proportion of the rear under portion of the tuyere by using an internal well diameter some 25 per cent less in diameter than the maximum or top of tuyere diameter of the shell. The tuyere then projects through refractory over a portion of its surface area.

With the suggested mechanism of lining formation it also becomes apparent that the thickening of the lining towards the top of the cooler, as shown in Fig. 4, is a fundamental factor not altered by the sloping of the shell. Thus the internal slope will always be more acute than the slope of the shell steelwork. Allowance for this lining thickness should therefore be made in the cooler shell design, as scaffolding or hanging may occur if a ridge of lining protrudes beyond the upper shaft diameter.

SIZE LIMITATION

As the cooling losses on this type of furnace are proportional to diameter, whereas useful heat production is proportional to the square of the diameter, there is a practical limit to the reduction of cupola size.

Many methods have been used to determine the useful heat available from given fuels. The method used by the author for calculations on these furnaces allows that:

- 1) in view of the need for metal temperatures of 1500 C minimum, (2732 F), the reaction zone temperatures will be high, and the main coke combustion will only proceed to some 9 per cent carbon dioxide.
- 2) some 2 per cent of the charged coke will be lost as fly ash and be ejected unburnt.
- 3) further carbon and heat will be lost in the endothermic reaction of blast moisture to form hydrogen and carbon monoxide.
- 4) heat will also be lost in the net process of calcining limestone for the formation of a slag with the coke ash, and melting and superheating such slag.
- 5) sensible heat will be lost in the combined effluent from the main combustion, the water gas reaction, and the limestone decomposition.
- 6) heat will be introduced by the blast.

If a coke of some 88 per cent fixed carbon, 1 per cent volatile matter and 11 per cent ash, half of which is SiO_2 , is used, and after allowance for lost CaO , a slag is formed of 1.25/1.0 CaO/SiO_2 ratio using limestone of 95 per cent CaCO_3 and 5 per cent SiO_2 and spar of 85.7 per cent CaF and 14.3 per cent SiO_2 with a blast temperature of 500 C (932 F), and an effluent temperature of 560 F, it can be shown that at

a coke burning rate of 1.54 lb per sq in. per hr (mean value for 40-in. furnace melting 11 lb per sq in. at 14 per cent coke), the useful heat production is some 10,000 Btu per hr per sq in. of combustion zone area.

This useful heat has to perform the following functions:

- 1) satisfy direct cooling losses from shell and tuyeres,
- 2) satisfy other radiation and unknown losses,
- 3) melt and superheat the iron with allowance for:
 - (a) the whole process of limestone decomposition, slag formation, melting and superheating, to give a correct slag from silicon lost from the metal and dirt carried in with the metal, and heat in the CO₂ effluent; (b) for heat gain from the oxidation of silicon, etc.

Now if items (1) and (2) are again deducted from the useful heat available, as calculated above for furnaces of different diameters, then the corrected useful heat is that which is truly available for item (3) above, the heat for metal processing. Using this method graphically it can be shown that:

- A) If the theory of cooling losses expressed above is valid, then using the higher level of losses, it becomes theoretically impossible to operate such a cupola below some 20 in. diameter to give adequate metal temperature, even with vastly increased coke percentages.
- B) To avoid radical deviation from the design criterion laid down, and to give a metal flow which can be handled through a continuous tapping system, the practical minimum size of furnace which should ever be considered is one of 33-in. diameter at the combustion zone, with a nominal maximum rating of 4 long tons per hr (approx). Efficiency and ease of operation will progressively increase as size increases above this minimum, until the difficulty of insuring sufficient blast penetration intervenes at some as yet unknown maximum.

INFERIOR FUELS

Using the same method of calculation in respect of an inferior coke of Indian origin showed that for use with a similar basic slag, derived from similar slagging materials, the weight for weight efficiency of the Indian fuel would only be 67.11 per cent of the United Kingdom fuel cited above, with blast at 500 C (932 F). However, if the ratio of coke was increased to keep the carbon burning rate constant, rather than the coke rate, then the useful heat production would be 90.8 per cent. It was considered however that peak combustion temperatures would still be adversely affected. The screening effect of the high ash causes a deepening of the combustion zone, the resulting loss of thermometric efficiency being accompanied by higher oxidation tendencies.

If a higher blast temperature were used, both these tendencies could be offset. An increase of blast temperature from 500 C (932 F) to 730 C (1346 F) would be sufficient to bring the useful heat per unit weight of carbon back to the same level as for U.K. coke of standard composition. This case was also interesting as the proposed plant was near the size limitation, an output of 6 tons per hr maximum, and 3 tons per hr minimum being requested.

ADVANTAGES OF THE PLANT

I. A unit has been produced which can be used for acid, neutral or basic melting at will. Slag is calculated as is the metal charge. It is found however in our own practice that some 20 per cent of the total CaO charged is lost presumably being carried out by the effluent stack gases. Thus all the sources of silica per charge are totalled:

- 1) silica from metal silicon loss,
- 2) silica from coke ash (less 2 per cent fly loss),
- 3) silica from limestone and spar,
- 4) silica from sand carried in with charges.

Similarly the total CaO resulting from limestone and spar additions is calculated, but only 80 per cent of this is assumed to be available and this 80 per cent is related to the silica total above to give the desired CaO/SiO₂ ratio in the slag. A total slag weight balance is obtained by allowing for the other components arising from the slag ash such as alumina, magnesia, etc.

II. The unit will in most cases be used as a basic melting unit, to enable carbon pick-up to be obtained and sulphur removal practised. Especially under European conditions this allows the use of charges compounded of cast iron and/or steel scrap plus ferro-alloys to produce high grade iron from cheap low grade raw materials.

III. Under such conditions, the use of hot blast has not only made the requisite metallurgical advantages of low iron oxide content, etc., an assured fact, but has restrained coke consumption to levels similar to cold-blast practice, while giving metal temperatures of a consistently high level, coupled with lowered silicon losses.

IV. Refractory problems, normally so aggravating in the basic cupola have been virtually eliminated.

V. The unit can be so designed, with due regard to automatic recuperator cleaning, and judicious cooling in metal and slag tap zones, so as to be capable of 24 hr per day operation for periods up to four weeks in duration. Thus where high cost repetition molding plant of the automatic type is to be run on a three shift basis to pay-off, or where steel scrap is being pre-melted as a molten raw material for further processing in a Siemens steel plant, i.e., wherever modern processes are demanding a continuous supply of controlled composition molten iron, this type of unit can fill the need.

THE FUTURE

A heat balance has been drawn up for the Dobson & Barlow 4-8 ton per hr plant working near its mid-range, i.e., at some 5.6 tons per hr, under conditions similar to those quoted by Henderson. This is shown in Table 1. From this it will be seen that the heat carried in by the blast is much less than that carried out by the latent and sensible heat in the effluent. In fact, if some 50 per cent overall recovery efficiency could be achieved, the blast temperature could virtually be doubled. This factor is believed to be of the greatest importance.

It has been demonstrated in our own experimental work that, for a slag of given basicity, the silicon loss has varied with furnace temperature. Losses of 25 per cent were experienced with metal temperatures

of some 1425 C (2600 F) and slag basicity of 1.25/1.30, whereas with similar slags this loss has been lowered to some 10 per cent with metal temperatures of some 1550 C (2822 F).

That silicon losses can be turned to silicon gains in an acid running furnace has been amply demonstrated by many workers. The point of transition from loss to gain is affected by both coke ratio and blast temperature. Each factor which increases both intrinsic furnace temperature, and the carbon monoxide makes furnace conditions more reducing.

TABLE 1.

Heat Sources	%
Potential Heat of Residual Fixed Carbon in Coke (after Fly Loss and Carburization Deductions)	87.23
Sensible Heat in Blast	10.36
Heat From Slag Reactions	0.63
Heat from Silicon Oxidation	1.78
	100.00
Heat Dissipation	
Carbon Reacting with Water	2.35
Endothermic Reaction Loss	0.70
Heat to Effluent from Reaction	0.09
	3.14
Limestone Decomposition	1.76
Heat to Effluent from Reaction	0.13
	1.89
Latent Heat in Major Effluent	40.94
Sensible Heat in Major Effluent	5.89
	46.83
Loss to Cooling Water	12.47
Other Radiation Losses (including errors)	4.47
Slag Melting and Superheating	2.29
Metal Melting and Superheating	28.91
	100.00
Total Heat in Effluent (at off-takes)	47.05
Present Returned Heat in Blast	10.36
Balance in Waste Gas (plus Recuperator losses)	36.69

It has been said that no silicon gain can possibly occur in the case of a basic slag, as no "free" silica exists. This however is in contradiction to the fact that a low silicon content arises in pig iron produced in a basic blast furnace. The author believes that when the amount of experimental work done is sufficient, a picture will emerge generally of the form shown in Fig. 10.

It is equally well acknowledged that the efficiency of the desulphurizing process with basic slag is rapidly increased as the iron oxide content of the slag falls to low values, and further that iron oxide content also falls with increasing furnace temperatures. Coke ratio and blast temperature again are the predominant factors, the mechanism being again one of reduction.

The unit described can already function as an acid, neutral or basic controlled slag cupola. In each capacity it can perform any of the functions which a lined cupola of similar acidity or basicity can perform once the lost heat to the cooling system has been nullified by extra fuel or blast temperature.

Both these means must be noted in the interests of accuracy. As in the case of the larger cupolas where the fraction of useful heat lost to the cooling is smaller, these units could obviously be operated cold blast. If this was done however, silicon losses, and iron

oxides would be higher, desulphurizing ability and metal temperatures lower. Also possibly some trouble would be experienced due to freezing at the tuyere nozzles, with consequent uneven furnace behavior. Present performance, with blast temperatures of 500 C (932 F) gives metal at some 1550 C (2822 F) or more from a 48-in. furnace running with 14 per cent coke and silicon losses, as quoted above, of some 10 per cent with slags of 1.25/1.30 CaO/SiO₂ ratio.

Satisfactory as these results may be, it is suggested that if the blast temperature were increased still further by using the surplus heat in the cupola effluent to the fullest possible extent, several advantages would accrue.

- 1) silicon losses could be reduced to very low values or nullified, (a) by the direct action of higher furnace temperatures or (b) by the use of less basic slags.
- 2) less basic slags could be used to achieve equal desulphurization as iron oxide values would be also lowered.
- 3) carbon pick-up would also be achieved to similar levels with less basic slags.
- 4) very smooth and steady furnace behavior would result. Our present favorable experiences in this direction, since the modification to furnace design previously described, no doubt will be excelled, especially in the handling of charges consisting mainly of steel scrap, the surface of which would precarburize more readily in a higher carbon monoxide atmosphere.
- 5) metal temperatures would rise still further.
- 6) poor fuels could be made to yield satisfactory irons in those districts of the world where high quality metallurgical coke is not available.
- 7) finally when sufficient advantage has been taken

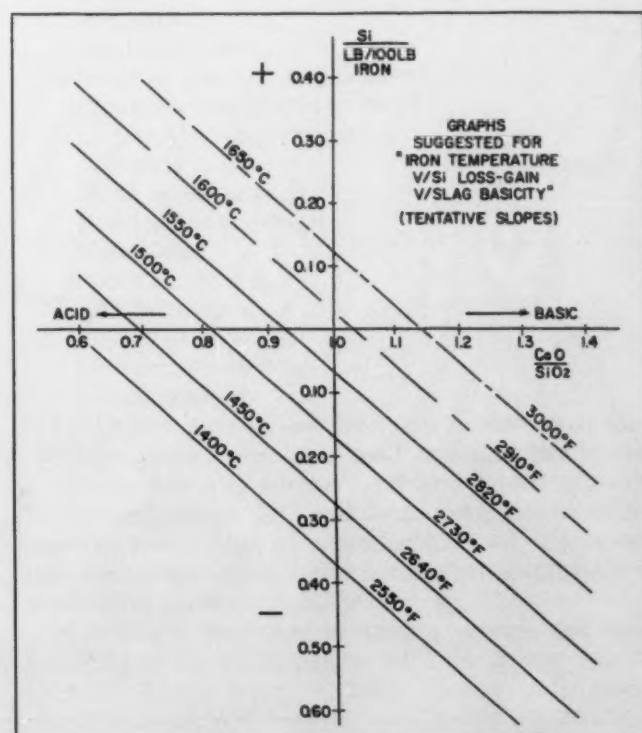


Fig. 10—Relationship between slag chemistry, silicon content, and metal temperature.

of any of these factors to suit the prevailing problem, any surplus blast heat would be offset by a reduction in coke usage, so that the best use would be made of the fuel at all times.

It has been long known that cupola efficiency could be theoretically improved by the use of higher and higher blast temperatures, with more and more return of the normally wasted latent and sensible heat of the effluent via the blast. However it is doubted whether previously the refractory-lined standard cupola would have long survived such a procedure carried to its logical conclusion. It is believed however, that the type of cupola described above now allows very high combustion zone temperatures to be used.

The final note of this paper therefore is a further challenge to the hot-blast equipment designer. He has played his part to date by meeting the demand for continuous automatic cleaning of standard recuperators, and by producing a 550 C (1022 F) recuperator which will stand the high operating pressures called for by high velocity tuyeres and yet remain virtually leakproof. Still needed is a recuperative system to give similar trouble-free operation up to temperatures possibly eventually as high as 1000 C (1832 F) while still being a low cost unit. A challenge indeed! The need however seems equally clear.

In conclusion the author would like to thank the Directors of Messrs Textile Machinery Makers Ltd., Dobson & Barlow Ltd., and Platt Brothers & Co. Ltd., for permission to publish data arising from work done on their behalf.

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This paper has been approved for presentation at the 62nd Annual Meeting of the American Foundrymen's Society, to be held in Cleveland, Ohio, May 19-23, 1958. The Society reserves all rights for publication either prior to or subsequent to presentation, and is not responsible for statements or opinions advanced herein.

WRITTEN DISCUSSION IS SOLICITED

PURCHASE SPECIFICATIONS FOR COMMONLY USED STEEL FOUNDRY MOLD AND CORE SAND BINDERS

By

E. G. Vogel*

The big word here, and the key word, is specification. Webster says it is the "Determination of a thing in its specific or particular character".

It has been our goal in our company for some time to establish some kind of a molding materials inspection program. Going back to that definition for a moment, I believe all we want (at least at first) is to be reasonably sure that we will receive materials consistent enough in their specific character so that they will not be major considerations in the making of good sands. In other words we want to eliminate the material variables in our sand problems picture.

One can look upon this program as consisting of two stages. Initially, any systematic program of inspecting binders will immediately provide the sand control man with a picture of his raw materials. He may, in contrast to the past, know for example that he is now making core sand with strong dry baking cereal and if his strengths are unduly high that he can make an adjustment in the cereal content addition until that cereal batch has been depleted.

A better understanding is now at hand; many sand quality variations can now be more adequately explained and dealt with.

Secondly, it is hoped that as time goes by foundry sand personnel will be able, in conference with vendors, to come to agreements concerning test parameters of acceptance covering all raw materials. This is, of course, the primary subject to which this paper is devoted.

Since we are manufacturers of an important product which must pass, in most cases, rigid requirements as prescribed by the buyer, then it should follow that the binders we buy as tools to produce this product should also be of a consistent quality. This is not intended as a taunt for our vendors and their employers, and yet I believe that the factor of consistency in

quality will become a more and more important salespoint as time goes by.

The materials which will be discussed here are bentonite, corn cereal flour, core oil, plastic core binder and cold set oil, primary catalyst included.

A list of tests used is as follows:

- Sand batch green compression
- Sand batch dry compression
- Sand batch mold hardness
- Sand batch dry shear
- Sand batch transverse strength
- Sand batch tensile strength
- Sand batch scratch hardness
- pH
- Density
- Viscosity
- Solids content

A list of equipment used is as follows:

- Laboratory muller 24-in. bowl
- Universal strength machine
- pH meter
- Mold hardness gage
- Powder density sifter
- Viscometer
- Scratch hardness
- Reel lab oven
- Drying oven
- Compressed air line
- 500 ml graduate

In the tests that follow involving conventional sand batch properties, we have used standard production sand mix formulas for core oil and liquid phenolic binder evaluations. This is done to get a picture of the material performing as a production tool. These two core formulas contain 4 and 5 ingredients respectively in addition to the sand and water.

In addition this type of testing reveals the compatibility of the oil or plastic with the balance of the formula. These formulas both contain corn cereal which in itself will vary in sand batch dry strength. It is necessary, therefore, to check a cereal and isolate a supply for these testing purposes. The cereal used

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to develop the oil and plastic acceptance test parameters shown in this paper must develop a psi dry shear figure between 130 and 140. This figure is developed using the corn cereal binder test method. If a cereal is used which will fall outside this range, the resin and oil bake strength parameters shown in this report cannot be referred to.

We practice the use of two sets of parameters. The first or control range is one, in our opinion, of ideal limits. Beyond these parameters we will accept shipments because we can still make minor changes to maintain our sand formula quality. The second range is generous on the high side since we can adjust for excessively strong material whereas excessively weak materials present too many problems. We are now speaking of a set of figures which we will use as a material shipment rejection criterion.

CORE OIL

The sand batch formula shown below is similar to one of our present production formulas.

TABLE 1 - 20 LB CORE OIL TEST BATCH

Standard 60 sand	—	16.70 lb	
120 silica flour	—	2.60 lb	13.30%
Standard cereal	—	82 grams	0.90%
Iron oxide	—	73 grams	0.80%
Core oil	—	168 grams	1.86%
Water	—	520 cc	
Dry mull	—	1 minute	
Wet mul	—	5 minutes	
Oil mul	—	2 minutes	

The so-called standard sand is a two-ton supply isolated for laboratory testing use. It is purchased in bags and has a screen distribution like our production sand (AFS 60). The test cores are baked at 430 F for 2 hours.

Solids Test

In checking for solids 10 grams of oil are weighed in a porcelain dish and then heated at 300 F. It is reweighed every 30 minutes until weight loss is constant.

The oil we use is from one manufacturer and is priced at \$0.14 per lb received at Lebanon in 10 drum shipments.

TABLE 2 - CORE OIL TEST PARAMETERS

	Control Range	Rejection Limits
Tensile (average of five)	290-320 psi	250-360
Transverse (average of five)	60- 80 psi	50-100
Scratch (average of five)	70- 80 psi	60-100
Solids (average of two)		65% min

LIQUID PHENOLIC PLASTIC CORE BINDER

The sand batch formula shown below is similar to one of our present production formulas.

We use plastic binder from three manufacturers and are paying about \$0.23 per lb delivered in Lebanon in 16 drum shipments.

Solids Test

The solids content is derived simply from the dehydration of a 10 gram sample of plastic in a 300 F oven and checked every 30 minutes to constant weight.

TABLE 3 - 20 LB PHENOLIC PLASTIC TEST BATCH

Standard 60 sand	—	16.40 lb	
120 silica flour	—	2.64 lb	13.20%
Standard corn cereal	—	163 grams	1.80%
Iron oxide	—	91 grams	1.00%
Plastic binder	—	60 grams	0.65%
Wood flour	—	91 grams	1.00%
*F.O.R.	—	41 cc	0.46%
Water	—	540 cc	
Dry mull	—	1.0 minutes	
Wet mull	—	4.5 minutes	
Plastic mull	—	2.0 minutes	
F.O.R. mull	—	0.5 minutes	
Oven temperature	—	430 F.	
Oven time	—	1 hour	

* F.O.R. is release agent made as follows: Fuel oil No. 2 - 4 volumes; Release agent - 1 volume.

TABLE 4 - PHENOLIC PLASTIC TEST PARAMETERS

	Control Range	Rejection Limits
Tensile (average of 5)	162 - 186	148 - 200
Transverse (average of 5)	28 - 36	24 - 40
Scratch (average of 5)	65 - 77	61 - 82
Viscosity of binder		1500 centipoise (max)
Solids (average of 5)	62 - 70%	

CORN CEREAL BINDER

We use the so-called heavy type corn about 400-500 grams per liquid quart measure (946 cc). The sand batch formula used is as follows:

TABLE 5 - 20 LB CORN CEREAL TEST BATCH

Standard 60 sand	19.8 lb	
Corn flour	0.2 lb	1%
Distilled water	410 cc	
Dry mull	1 min	
Wet mull	7 min	
Oven temperature	400 F	
Bake time	1 hour	

TABLE 6 - CORN CEREAL TEST PARAMETERS

	Control Range	Rejection Limits
Green compression (average of five)	0.3-1.0 lb	0.2-1.2 lb
Dry shear (average of five)	130-140 lb	120-150 lb
Transverse (average of five)	15-30 lb	12-35 lb
Density (sifted) (average of two)	440-500 lb	420-560 lb

COLD SET OIL

This is one of the newer core binders available to the foundryman today but essentially it is not vastly different from our conventional core oils. As you know, it has the unique property of providing core sand rigidity in the core box in as little time as 30 minutes following mill discharge. At this writing, we have tried to evaluate the ability of the oil to oxidize or take on oxygen by aerating. This is done by bubbling air through the oil and then checking the resultant increase in its viscosity. In addition, we check the mold hardness development, the tensile strength of a conventional sand mixture after baking and also the viscosity of the oil.

Oxidation Viscosity by Aeration

1. Use dry air.
2. Bubble through 5 mm bore glass tube into 500 cc of cold set oil.
3. The oil is in a 500 ml graduate and the tube is immersed to within 1/4-in. of the graduate bottom.

- The oil should be held at a constant temperature; plus or minus one degree.
- The air must also be fairly constant in temperature; plus or minus one degree.
- The air is bubbled through the oil at about 500 cc per minute.
- The viscosity is checked before and after 3-hr aeration by a viscometer.
- We find a viscosity increase at 75 F of about 7.5 per cent. This is a figure obtained with insufficient testing to provide a reliable set of parameters.

TABLE 7 - 20 LB COLD SET OIL TEST BATCH

Standard 60 sand	20.00 lb
Cold set oil	136 gr - 2%
Perborate	12 gr - 9% of oil
Sand temperature	80 F
Sand + perborate mull	1 minute
Oil mull	3 minutes

Tensile Strength

Due to the excellent flowability of cold set oil sand mixtures, it is necessary to have at least three standard tensile core boxes if the sand tensile strength test is to be made. We use our regular tensile box plus our double flowability tensile box. The sand mix is poured into the three boxes, wrapped three times, struck off and is allowed to set for one hour.

The tensile briquettes are now strong enough for stripping onto the steel core carrying plates. They are then baked in an oven at 430 F (221 C) for one hour. They should be room cooled for one hour and tested.

Mold Hardness Development

When the tensile boxes are being filled, two 5-in. diameter pie tins are also filled by moderate pressure of the fingers and then neatly struck off. A certain hardness will develop in a given length of time. A mold hardness of 75 is checked in minutes and is used as a test. A mold hardness tester is used and it is felt that 75 is a mold strength sufficient to permit successful core box removals.

Viscosity

The viscosity of oils received should be checked since poor fitting drum closures, excessive age, or improper manufacture may produce an oil so viscous that it may tap at unacceptably slow rates and mix poorly with the sand in mulling.

TABLE 8 - COLD SET OIL TEST PARAMETERS

	Control Range	Rejection Limits
Oxidation viscosity development		Insufficient Data
75 mold hardness development	30 minutes	90 minutes
Tensile of baked core	245-275	220-315
Viscosity	1500 centipoise (maximum)	2500 centipoise (maximum)

BENTONITE

This material is probably the foundryman's most singly indispensable binder. To replace it with some other kind of material and retain the set of molding sand characteristics with which we are familiar would indeed take some doing.

In green sand work no other material serves us both at room temperature and pouring temperature as does bentonite.

With this importance recognized probably more evaluation work has been done on bentonite than on any of the other binders. In addition there is probably no more difficult material to evaluate than bentonite. Among the kinds of tests that have been investigated are:

Sand + Bentonite Tests

Green compression
Green shear
Green tensile
Green mold hardness
Green permeability
Green flowability
Green deformation
Green jolt resistance
Dry compression
Dry shear
Dry tensile
Hot compression strength
Hot deformation

Tests on Bentonite Alone

Viscosity
pH
Settling time
Liquid limit
Moisture content
Chemical analysis

Most investigators will quickly admit that no one test today is a satisfactory guard against poor bentonites. The writer is not one to take issue with this group. From experiences in this laboratory, it is felt that casting metal into a standard mold made of a standardized sand bentonite mix plus the hot compression test gives the most trustworthy evidence of a good, mediocre, or poor bentonite. The liquid limit test is considered, at this writing, having possibilities of being a single test for evaluating bentonite. Since time has permitted no experience with this test it will not be dwelt upon in this paper anymore than to say it is based on a relationship between bentonite slurry water contents and developed slurry rigidities. It is part of the S.F.S.A. tentative specification for western bentonite No. 13T. We use the following tests:

Sand batch (1)
Green compression
Dry compression
Mold hardness
Hot compression (Sand Batch 2)
and observation of the pH of bentonite, S.F.S.A.
scab test casting using sand batch No. 2.

TABLE 9 - 20 LB TEST BATCH NO. 1

Standard 60 sand	19.4 lb
Bentonite	0.6 lb (272 gr) 3%
Distilled water	290 cc
Dry mull	1 minute
Wet mull	7 minutes
Oven temperature	230 F
Oven time	7 hour

TABLE 10 — 20 LB SAND TEST BATCH NO. 2

Standard test sand	18.8 lb
Bentonite	454 gr 5%
Standard corn cereal	91 gr 1%
Water	410 cc
Dry mull	1 minute
Wet mull	7 minutes

pH Slurry

Distilled water—100 cc

Bentonite—8 g

Pour water into blendette first, sift bentonite into swirling water cone. Stir for 10 min.

Mold Hardness Test

This test can be conveniently run by testing the green compression plugs by partially stripping so that an impression can be made on the surface in previous contact with the rammer head.

Hot Compression Test

This test is quite useful and must be considered somewhat authentic since the bentonite is being subjected to high heat which is what takes place when metal is being cast against it. Unfortunately, it does require an apparatus of some expense.

The test consists of drying 2x1-1/8 in. rammed cylinders of sand mix No. 2. These are dried at 230 F for 1-1/2 hr. They are soaked at the temperatures shown below for 12 min, after which they are compressed until crush failure. At least three plugs should be tested at each temperature.

We have found a good bentonite will come up strong at 1500 F. Note carefully the strengths at 1500, 1600, 1700, 1800 and 1900 F. Our tests indicate that a good bentonite has strength readings above 510 for at least three consecutive temperatures. For example:

TABLE 11 — HOT COMPRESSION COMPARISONS

	Good Bentonites		Poor Bentonites	
	(1)	(2)	(3)	(4)
1500 F	550	570	360	450
1600 F	565	585	375	510
1700 F	570	590	390	670
1800 F	330	392	210	480
1900 F	210	211	85	205

pH Test

Use the slurry described and take pH readings every 5 min until constant.

Test Casting Observation

The sand batch No. 2 is used as a liberal facing with at least 1-in. coverage over the standard test pattern. Sand facing must be riddled thru a 6-mesh screen and backed with suitable heap sand. The sand compaction should be done on a jolt machine using 25 jolts. A carbon steel (0.20-0.30 C) poured from a skimmed 50-lb ladle at 2950 F will provide sufficient abuse to separate a good bentonite from a bad one.

TABLE 12 — BENTONITE TEST PARAMETERS

	Control Range	Rejection Limits
No. 1 sand batch green compression	2.2 - 3.2 psi	2.0 - 3.5 psi
No. 1 sand batch dry compression	35-55 psi	30-60 psi
No. 1 sand batch mold hardness	75-80 psi	70-85 psi
No. 1 sand batch hot compression	510 psi minimum for any three consecutive temperature applications.	
1500 F		
1600 F		
1700 F		
1800 F		
1900 F		
pH of prepared slurry	8.2 minimum	
Sand batch 2 standard casting	Observe flat ingate particularly for erosion.	

To ram up a mold and pour a controlled test casting for every carload of bentonite may seem like an unnecessary or excessive effort. Actually this may be reserved as a final check method in the event that any of the preceding check parameters are not met.

The foregoing program has been in effect at Lebanon for less than one year. Much of the method used is admittedly time consuming and difficult to control; therefore any simplifications of testing which will give useful data will of course be immediately considered. The liquid limit test for bentonite, for example, sounds very promising since it is quick and may allow discontinuance of some of the other tests.

The rejection parameters are intentionally liberal to permit vendors to adjust if necessary without too much difficulty. Narrowing the parameters is something that should definitely be envisioned for the near future.

I hope this paper has given you a clear picture of what one foundry is doing to control the quality of its sand binder purchases.

This paper has been approved for presentation at the 62nd Annual Meeting of the American Foundrymen's Society, to be held in Cleveland, Ohio, May 19-23, 1958. The Society reserves all rights for publication either prior to or subsequent to presentation, and is not responsible for statements or opinions advanced herein.

WRITTEN DISCUSSION IS SOLICITED

EFFECT OF PRESSURE DURING SOLIDIFICATION ON MICROPOROSITY IN ALUMINUM ALLOYS

By

S. Z. Uram,* M. C. Flemings** and H. F. Taylor***

ABSTRACT

Aluminum alloys 356 and 195 were solidified under pressures varying from atmospheric (15 psi) to 16.7 times atmospheric (250 psi). Pressures greater than atmospheric were found to result in a substantial reduction of microporosity in sand cast test specimens. The test castings were adequately risered, and the alloys thoroughly degassed.

The reduction in porosity effected by greater-than-atmospheric pressure during solidification was found to result in little improvement of mechanical properties in solution treated and aged test bars.

An analysis of the test results indicates that the microporosity in the test specimens studied was probably caused primarily by precipitation of minute amounts of gas during solidification.

INTRODUCTION

Commercial aluminum sand casting alloys are inherently prone to microporosity. The porosity appears as fine voids at grain boundaries or between dendrite arms; these voids may be large enough to be visible with the naked eye or they may be so small that careful metallographic techniques are required to observe them.

Potential sources of microporosity include (1) precipitation of dissolved gases, (2) solidification shrinkage, or (3) a combination of both gas and shrinkage. Whichever the source, dispersed microporosity arises because of the mode of solidification of sand cast aluminum alloys. These alloys do not freeze progressively from the mold wall inwards; they freeze in a pasty or "mushy" fashion. Nucleation occurs nearly simultaneously throughout the casting, and during most of the solidification process, solid and liquid exist in intimate contact over the entire casting. The solid-liquid mixture has the consistency of paste, or "mush", and hence the term describing its solidification.

Because of the mushy nature of solidification, in-

dividual, more or less isolated, pools of liquid may exist between grains or between dendrite arms late in the solidification process. If dissolved gas is present in the liquid metal it tends to concentrate in the last metal to freeze, and finally to precipitate as a gas hole; the result is distributed "gas-type" microporosity. Further, if an open feed channel is not maintained to each individual pool of liquid, solidification shrinkage may also result in microporosity. It is generally considered that dissolved gases and interdendritic shrinkage can reinforce each other in the formation of voids.

In relatively large amounts, microporosity is known to be quite deleterious to mechanical properties of aluminum alloys^{1,2} and to result in a lack of pressure tightness. In smaller amounts, microporosity probably also impairs mechanical properties, although a safe "minimum" amount has not been established. It is, therefore, important to keep such porosity to a minimum in quality commercial castings, and techniques for accomplishing this are (1) adequate degassing, and (2) directional solidification.

Careful degassing techniques (in combination with adequate risering) reduce microporosity in aluminum alloy castings to a very low value—to a point where the microporosity cannot be seen visually or by x-ray examination. Degassing and risering alone, however, do not completely eliminate the microporosity; even with optimum melting practice and risering techniques, microporosity may still be detected in aluminum alloy sand castings. Heavy chilling, in combination with adequate degassing and risering is necessary to produce commercial sand castings of these alloys essentially free of microporosity.³

The present work represents an attempt to determine if microporosity in aluminum alloy sand castings can be substantially reduced by application of hydrostatic pressure during solidification. Previous work has illustrated that such pressure will reduce microporosity and improve mechanical properties of alloys which are saturated with hydrogen,⁴ but the present work was undertaken with alloys as completely degassed as possible. Additional objectives of this investigation were to determine if any reduction in microporosity, if found, would result in appreciable improvement of

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Based on a thesis submitted by S. Z. Uram in partial fulfillment of the requirements for the degree of Master of Science, Department of Metallurgy, Massachusetts Institute of Technology.

mechanical properties of the alloys, and to gain an insight into the mechanism of formation of microporosity in well-fed, well-degassed aluminum alloy sand castings.

PROCEDURE

Test Pattern and Pressure Chamber

The test pattern used throughout this work is sketched in Fig. 1. The total weight of the casting (including riser) is 8.3 lb; the test section itself weighs 2.0 lb and is large enough to permit standard 0.505-in. diameter, 2-in. gage tensile bars to be cut from it for test. The pattern was molded in oil-bonded core sand for all tests.

The test casting described was solidified under hydrostatic pressures varying from 15 psi (one atmosphere) to 250 psi (17 atmospheres). In each heat produced, a control casting was solidified at 15 psi by pouring a casting in the open atmosphere; a second casting was solidified at higher pressure by pouring in

the apparatus shown in Fig. 2. The apparatus, a pressure chamber, permitted pouring the test casting with an ordinary ladle; subsequently the chamber could be sealed and nitrogen gas admitted from a storage tank until the pressure reached the desired level. Solidification of the casting then took place under the applied pressure.

Melting, Pouring, Solidification Practice

Six heats were poured, three of 356 alloy (nominal analyses—7% Si, 0.3% Mg, 0.18% Ti) and three of 195 alloy (nominal analyses—4.5% Cu, 0.18% Ti). Melting stock was composed of high purity virgin materials; aluminum pig (99.9%), Al-Si hardener (50% Si), Al-Cu hardener (50% Cu), magnesium (99.9%), and Al-Ti hardener (5% Ti) were used.

In the melting practice of both alloys, the high purity aluminum pigs were charged first, and non-volatile alloying elements (all alloying elements except the magnesium) added shortly after melting began. The magnesium was added to the 356 alloy melt just before degassing. Degassing was accomplished with a special grade of dry nitrogen (dewpoint, -73 F). Nitrogen was bubbled through the melt for 15 min. at 1200 F to 1300 F. Gas content was checked with a reduced pressure tester; the metal was held 5 min. to alloy dross flotation, and poured.

Two castings were poured in each heat. A control casting was first poured at atmospheric pressure; covered with gypsum; and allowed to solidify. A second casting was then poured in the pressure chamber through the runner system shown in Fig. 2. The core containing the runner was removed; the casting covered with gypsum; and the door to the pressure chamber then closed. Nitrogen gas was admitted to the chamber until the pressure reached the desired level (pressures of 60 to 250 psi were employed). A total of 3 min. was required between the time the casting was poured and the chamber was brought up to pressure. Thermal analysis indicated that appreciable solidification had not occurred in this interval. The casting was found to solidify completely in 23 min. and pressure in the chamber was released after 30 min.

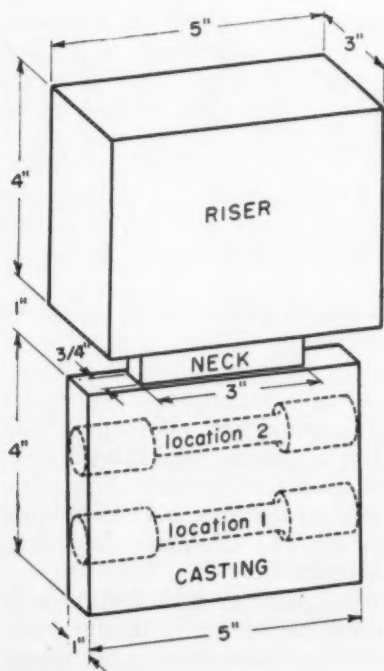
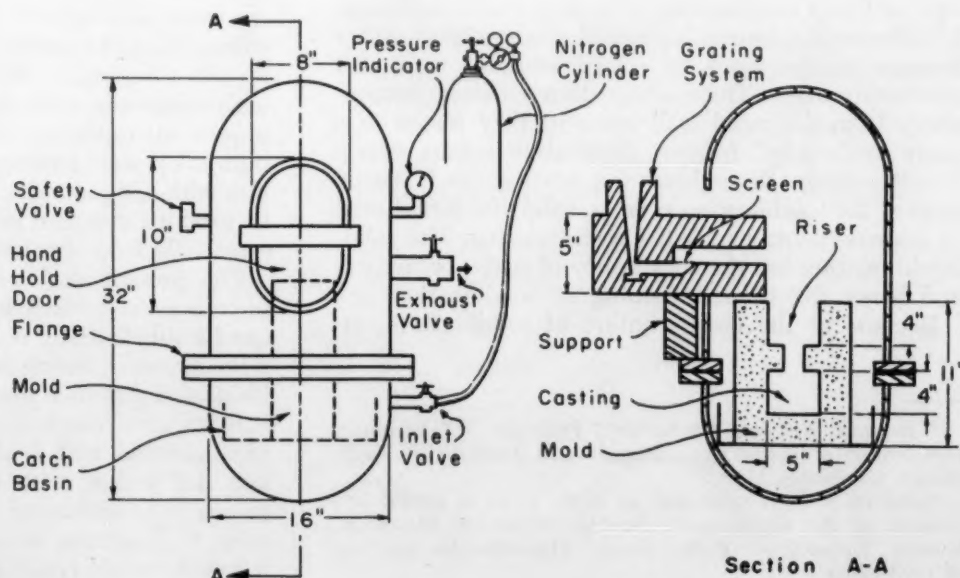


Fig. 1—Casting design showing test bar locations.

Fig. 2—Diagram of apparatus (not to scale). Section AA shows gating and mold assembly.



Heat Treating and Testing

After solidification, all castings were heat treated and aged. The following heat-treating schedules were used:

(a) 356 Alloy

Solution treat 1000 F, 16 hr.; water quench; hold at room temperature, 24 hr. minimum; age 310 F, 12 hr.

(b) 195 Alloy

Solution treat, 960 F, 16 hr.; water quench; hold at room temperature, 24 hr.; age 310 F, 12 hr.

A 1-in. thick section was cut through a vertical plane of the entire casting plus riser (in the same plane as the test bars shown in Fig. 1). The section was milled flat to 0.70 in. and radiographed. Typical radiographs are shown in Figs. 3 through 6.

After x-raying, test bars were cut from each slab as shown in Fig. 1. Standard 0.505 in. diameter, 2-in. gage length bars were cut and pulled after heat treatment to determine a possible effect of pressure during solidification on mechanical properties.

In order to examine the effect of pressure on porosity on a micro scale, a small piece (about 1/2 in. square x 1/8 in. thick) was cut from the center of each casting and polished parallel and smooth to a thickness of 0.010 in. The section was radiographed, and the radiographs enlarged 10 diameters. Typical final microradiographs are shown in Figs. 7 through 10.

RESULTS

Hydrostatic pressure during solidification has a pronounced effect on the distribution of solidification voids in cast aluminum alloys. Figure 3 illustrates a

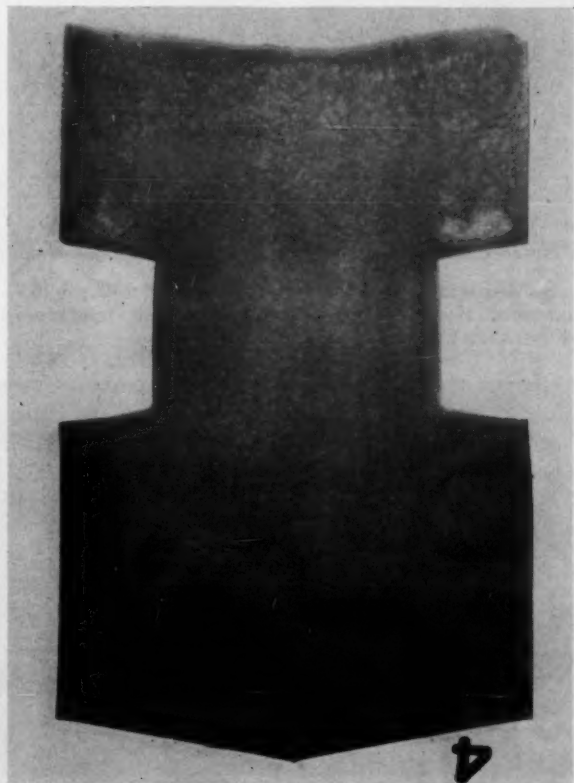


Fig. 3—Radiograph of center section of 195 alloy casting solidified under 15 psi (one atmosphere). Heat b.

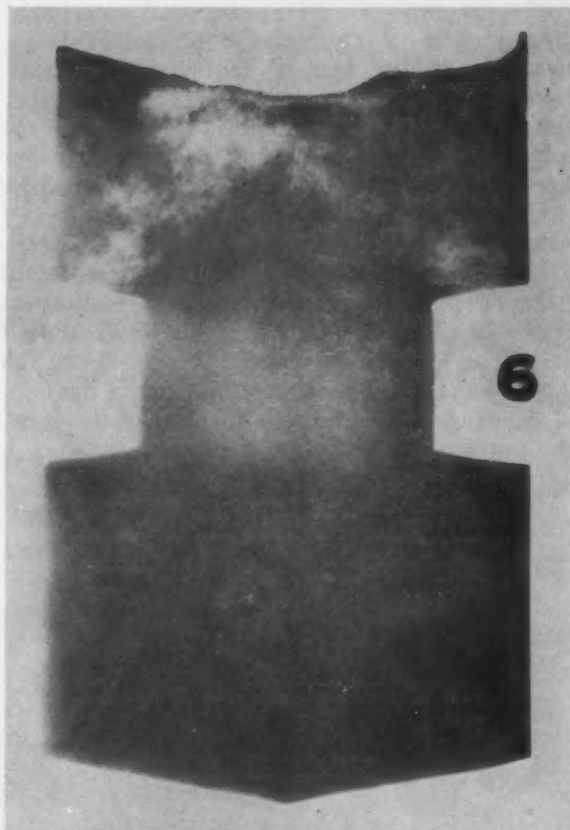


Fig. 4—Radiograph of center section of 195 alloy casting solidified under 100 psi (6.7 atmospheres). Heat b.

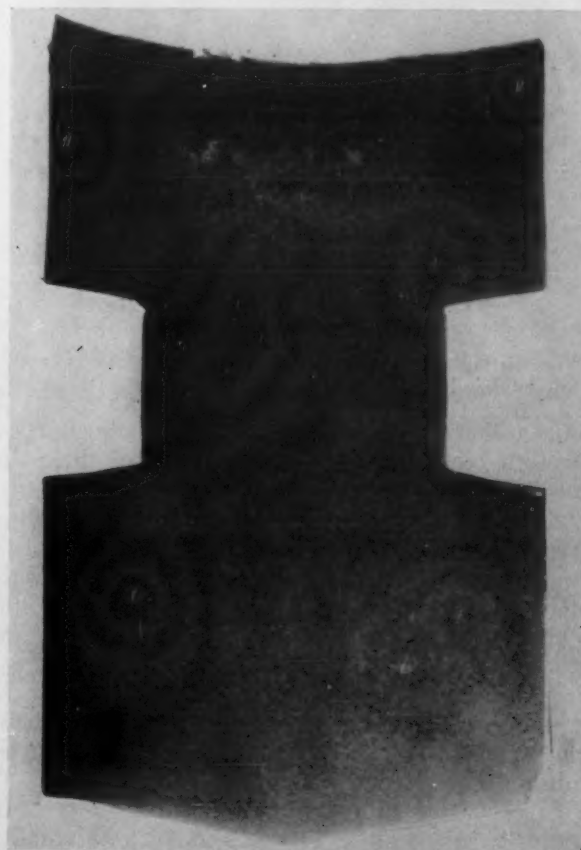


Fig. 5—Radiograph of center section of 356 alloy casting solidified under 15 psi (1 atmosphere). Heat c.

typical radiograph of a 0.7-in. section from a 195 alloy casting poured at atmospheric pressure. The riser shows little dishing, but substantial dispersed microporosity is evident in the test section of the casting itself. Figure 4 illustrates a similar radiograph from a casting of the same heat, but solidified at 100 psi. (6.7 atmospheres). The riser is dished more noticeably; a more localized shrinkage is observed in the riser; and the casting itself appears sounder.

Figures 5 and 6 illustrate typical radiographs showing the effect of pressure on the solidification structure of 356 alloy. The casting of Fig. 5 was solidified at atmospheric pressure, and that of Fig. 6 was solidified at 250 psi. (17 atmospheres). Again a more localized shrinkage is observed in the riser of the pressure cast sample. The radiographs do not reveal a sub-

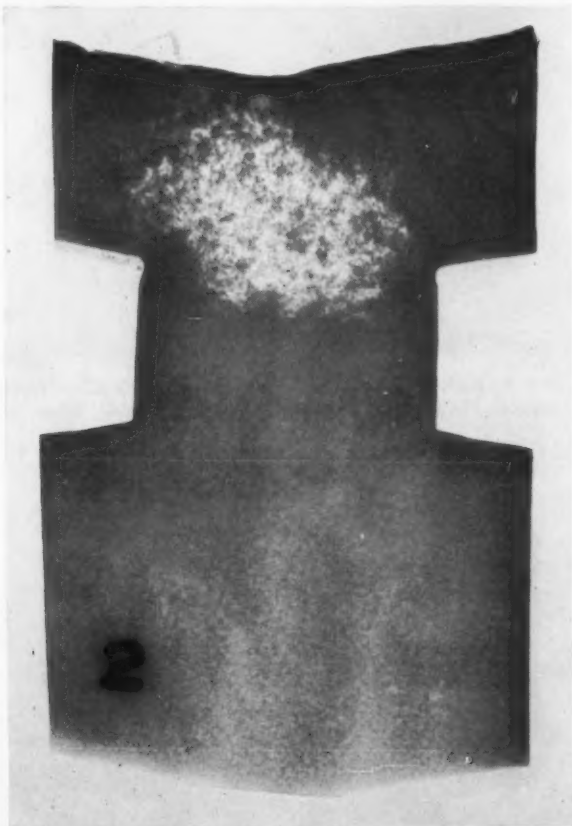


Fig. 6—Radiograph of center section of 356 alloy casting solidified under 250 psi (16.7 atmospheres) Heat e.

stantial difference in soundness between the test section of the casting solidified at one atmosphere and that solidified at 17 atmospheres.

Figures 7 and 8 illustrate more directly the effect of pressure on microporosity in 195 alloy. Figure 7 shows a microradiograph of a sample taken from the center of the test section of a 195 alloy casting solidified at one atmosphere (sample taken from just above center of bar No. 1 (Fig. 1). Random, relatively large micropores are apparent. Figure 8 illustrates the effect of increasing the pressure to 6.6 atmospheres during solidification of a casting from the same heat. A substantial reduction in microporosity is visible.

Figures 9 and 10 illustrate the effect of pressure on porosity in 356 alloy. Figure 9 shows a microradiograph of a casting solidified at one atmosphere, and Fig. 10 shows a microradiograph of a casting from

the same heat solidified under 16.7 atmospheres. The samples were taken from the center of the test section, just above bar No. 1 (Fig. 1). A reduction in void size due to the application of pressure during solidification is apparent (Figs. 9 and 10).

Tables 1 and 2 illustrate that the reduction in microporosity brought about by increasing hydrostatic pressure is not accompanied by a substantial increase in mechanical properties of well fed, well degassed castings. In the case of 195 alloy (Table 1), increasing pressure appears to increase the ultimate tensile strength by about 2000 to 4000 psi. No increases in yield strength or elongation are detected. In the case

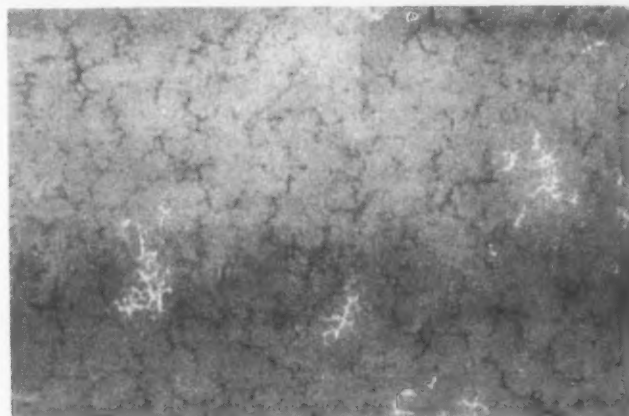


Fig. 7—Microradiograph of 195 alloy solidified at 15 psi (1 atmosphere). Heat b, $\times 10$. Light areas are microporosity. Dark areas are aluminum-copper undissolved intermetallic.

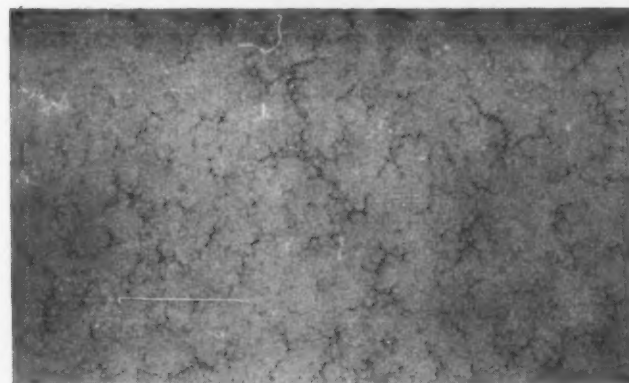


Fig. 8—Micrograph of 195 alloy solidified at 100 psi (6.7 atmospheres). Heat b, $\times 10$. Light areas are microporosity. Dark areas are aluminum-copper intermetallic.



Fig. 9—Microradiograph of 356 alloy solidified at 15 psi (1 atmosphere). Heat e, $\times 10$. Light areas are microporosity.



Fig. 10—Microradiograph of 356 alloy solidified at 250 psi (16.7 atmospheres). Heat e, X10. Light areas are microporosity.

TABLE 1 — MECHANICAL PROPERTIES OF 195 ALLOY CASTINGS SOLIDIFIED AT VARIOUS PRESSURES

Heat No.	Test Bar Location*	Pressure		U.T.S.	Y.S.	% El. in 2 in.
		psi	Atmosphere			
a	1	15	1	35,000	30,000	3
	1	60	4	37,000	29,000	3
b	1	15	1	32,700	27,500	3
	1	100	6.7	36,500	30,000	3
c	1	15	1	36,600	30,000	3
	1	250	16.7	41,000	30,000	4

*Test bar location numbers refer to Fig. 1.

TABLE 2 — MECHANICAL PROPERTIES OF 356 ALLOY CASTINGS SOLIDIFIED AT VARIOUS PRESSURES

Heat No.	Test Bar Location*	Pressure		U.T.S.	Y.S.	% El. in 2 in.
		psi	Atmosphere			
c	1	15	1	34,700	31,300	2
	2	15	1	34,200	30,800	2
	1	100	6.7	35,400	31,300	2
	2	100	6.7	34,700	30,800	2
d	1	15	1	36,100	32,500	2
	2	15	1	36,700	34,000	2
	1	160	10.7	38,500	32,500	2
	2	160	10.7	37,400	34,500	2
e	1	15	1	38,100	33,900	2
	2	15	1	37,300	34,000	2
	1	250	16.7	38,000	33,900	2
	2	250	16.7	37,500	33,900	2

*Test bar location numbers refer to Fig. 1.

of 356 alloy (Table 2), pressure during solidification had little or no beneficial effect on mechanical properties.

DISCUSSION

Solidification of 356 alloy and 195 alloy sand castings under pressure has been shown to result in a substantial reduction of microporosity in the alloys. The marked reduction in microporosity, due to applied pressure, makes it appear likely that the voids in the well fed test section used in this study were caused primarily by the precipitation of gas during solidification.

The only gas soluble in appreciable quantities in aluminum and its alloys is hydrogen.⁶ The solubility of this gas in pure aluminum is 0.7 cc per 100 grams (standard temperature and pressure) while the solubility in the solid is only 0.04 cc per 100 grams (standard temperature and pressure).⁷ Since the solubility in the solid is so low, it is quite possible that even the most effective degassing methods in commercial use may leave enough hydrogen in solution to precipi-

tate fine voids during solidification.

Pressure applied during the solidification process tends to reduce the size of gas-caused micropores in two ways. It tends to increase the solubility of the solid for hydrogen according to Sievert's law:¹

$$C_s = K \sqrt{P} \quad (1)$$

where C_s = solubility of hydrogen in solid (cc/100 gms, STP)

K = constant (0.04 cc STP/100 gms x atm.)

P = pressure of hydrogen in micropore, assumed equal to the applied pressure (atm.).

By increasing the solid solubility for hydrogen, applied pressure decreases the amount of hydrogen available to form a void.

Pressure also decreases the size of gas-caused micropores according to Boyle's law:

$$V_v = C \left(\frac{1}{P} \right) \quad (2)$$

where V_v = Volume of micropore (cc)

C = constant (atm.-cc)

P = applied pressure (atm.).

Figure 11 illustrates how applied pressure affects the amount of "gas-type" micropores in aluminum castings; per cent void volume is plotted versus the initial hydrogen concentration for three applied pressures. The graph was developed from equations (1) and (2) in the manner outlined in the Appendix. The assump-

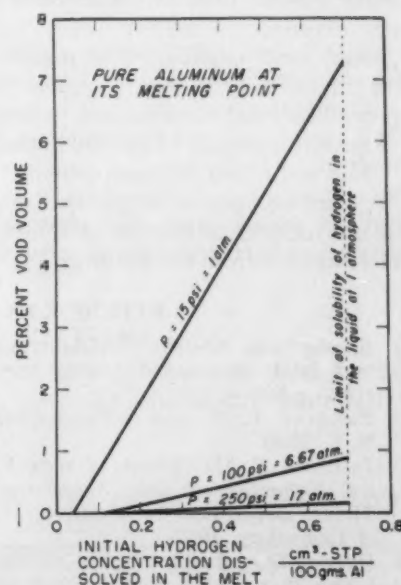


Fig. 11—Curve showing effect of applied pressure on gas controlled void volume in pure aluminum.

tions involved in Fig. 11 are also listed in the Appendix. For simplicity, the gas solubility constants employed in the calculation were those for pure aluminum.

Figure 11 illustrates that when voids are caused by precipitation of hydrogen, increasing the applied pressure during solidification substantially reduces void volume. It also shows, however, that the pressures employed can completely eliminate microporosity only when the amount of hydrogen initially dissolved in the liquid metal is very low (i.e., only in extremely well-degassed aluminum). The microradiographs of Figs. 7 to 10 illustrate that in this work, pressure substan-

tially reduced microporosity but did not completely eliminate it.

As mentioned previously, the marked effect of pressure on microporosity makes it appear likely that the voids in the castings studied were caused primarily by gas. If the voids were not caused primarily by gas, but were caused by solidification shrinkage, pressure might conceivably result in a reduction of their size in two ways. It might result in some plastic working, or "hot forging" of the metal, closing pores already formed, but this appears unlikely at the pressures involved.

Pressure might also result in a reduction of "shrinkage-type" micropores by forcing the liquid metal through the narrowing feed channels to the more or less isolated pools of liquid metal. However, in view of previous theoretical analyses of solidification⁵ it appears unlikely that the pressures employed here would result in much reduction of porosity by this mechanism.

While the pressures employed in this work substantially reduced microporosity, little improvement in mechanical properties due to the increased pressure was noted. Thus, the application of pressure during solidification does not appear to be a feasible method for improving the mechanical properties of well degassed, well risered, commercial aluminum alloy sand castings.

SUMMARY

Solidification of two aluminum alloys under pressures greater than atmospheric resulted in a substantial decrease in microporosity in well fed, well degassed sand castings. The marked effect of pressure on the porosity makes it appear likely that the micropores observed were caused primarily by precipitation of minute amounts of gas during solidification.

The reduction in microporosity due to the applied pressure was not accompanied by appreciable increase in mechanical properties of solution treated and aged test bars cut from the castings.

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ACKNOWLEDGEMENTS

The authors express their appreciation to the American Brake Shoe Company for the Fellowship which made this work possible, and to the Instrumentation Laboratory, M.I.T., for the added financial support necessary to purchase the experimental equipment.

APPENDIX

Relationship between dissolved hydrogen and final per cent porosity in cast aluminum.

Assumptions:

- 1) There is no evolution of gas from the casting to the surroundings. That is, all gas dissolved in the melt remains as gas bubbles or is dissolved in the solid after solidification.
- 2) Boyle's Law and Sievert's Law are obeyed.
- 3) The pressure of hydrogen in the bubble formed is equal to the applied pressure at the temperature of formation.
- 4) Pressure variation in the casting due to hydrostatic head of the metal is neglected.
- 5) Diffusion of hydrogen in solid and liquid aluminum is perfect.

In the present case, consider pure liquid aluminum at its melting point with an initial hydrogen concentration of C_0 (cc/100 gms at S.T.P.) dissolved in it. The amount of hydrogen, C^1 , available to form pores in the metal is the difference between the amount initially dissolved in the liquid metal, C_0 , and the amount of hydrogen soluble in the solid, C_s . That is:

$$C^1 = C_0 - C_s \quad (1)$$

where C^1 = volume of hydrogen available to form a void (cc/100 gms at S.T.P.)

C_0 = initial concentration of hydrogen in liquid (cc/100 gms at S.T.P.)

C_s = solid solubility (cc/100 gms at S.T.P.)

The solid solubility varies with applied pressure according to Sievert's Law:

$$C_s = K \sqrt{P} \quad (2)$$

where K = constant (0.04 cc S.T.P./100 gms x atm.^{1/2})

P = applied pressure in atm.

In a 100 gram sample the volume of hydrogen in the form of pores at S.T.P. will be equal to C^1 (Equation (1)). However, the voids are actually formed at the melting point of aluminum 660 C (933 K) and at an applied pressure of P atm. Therefore, by Boyle's Law, the volume of voids, V_v , at temperature T = 933 K and at pressure P for a 100 gram sample is:

$$V_v = K^1 C^1 \left(\frac{T}{P} \right) \quad (3)$$

where V_v = volume of voids, cc

K^1 = constant = $1/273$ atm° Kelvin

T = temperature = 933 Kelvin.

Combining Equations (1) through (3) yields:

$$V_v = (C_0 - K \sqrt{P}) K^1 \frac{T}{P} \quad (4)$$

Since 100 grams of aluminum occupy a volume of $\rho/100$ grams where ρ is the density of aluminum (2.7 gms/cc), the volume of voids may be expressed on a percentage basis as:

$$\%V_v = (C_0 - K \sqrt{P}) \frac{\rho K^1 T}{P} \quad (5)$$

Thus, for a given initial hydrogen concentration in molten aluminum bath, and a given applied pressure, the percentage of gas voids in final structure may be calculated from Equation (5). Results of a series of such calculations shown in graph of Fig. 11.

This paper has been approved for presentation at the 62nd Annual Meeting of the American Foundrymen's Society, to be held in Cleveland, Ohio, May 19-23, 1958. The Society reserves all rights for publication either prior to or subsequent to presentation, and is not responsible for statements or opinions advanced herein.

WRITTEN DISCUSSION IS SOLICITED

FOUNDRY CHARACTERISTICS OF A RAMMED GRAPHITIC MOLD MATERIAL FOR CASTING TITANIUM

By

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ABSTRACT

The surface finish, shrinkage, compressive strength, permeability and thermal conductivity of an expendable graphitic mold have been determined. The amount of surface contamination of titanium cast into this type of mold has also been ascertained. All of the variables were studied as functions of the molding pressure and moisture content of the graphitic material.

The material fabricated with 6 per cent by weight of water and compacted at 123 psi pressure provided a satisfactory mold into which molten titanium could be cast.

INTRODUCTION

The technique of casting uncontaminated, superheated titanium has been facilitated by the development of the consumable electrode-vacuum arc melting furnace. One problem still remaining as an obstacle to the establishment of a satisfactory and economical titanium casting process is that of a suitable expendable mold material. At the present time, machined graphite or massive copper molds¹ are employed for the production of titanium castings free from embrittling surface contamination. These types of molds are expensive to produce and have practical geometric limitations. In addition, in the case of machined graphite, the life of the molds is limited to a few castings.

Various refractories have been tested to determine their feasibility for use as mold materials. The most promising of these materials can offer only a marginal solution to the existing problem.² Recently, however, Feild³ and Feild and Edelman⁴ have developed a powdered graphite mold which has shown promise.

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This type of mold is composed of powdered graphite (the basic material) with starch, carbonaceous cement and pulverized pitch as binders. Water mixed with a surface activating agent is used as the vehicle. Molds are made by pressing a mulled mixture of the components around standard wooden or metal patterns. The pressed molds are stripped from the patterns, air dried, baked and then fired. Titanium cast into these molds exhibited little surface contamination.

In view of these encouraging results, it was felt that a comprehensive study of some of the variables of this material on its foundry characteristics should be made. The parameters that were chosen for immediate investigation were moisture content and molding pressure.

MATERIALS

Electric furnace graphite powder was used as the basic material. The sieve analysis of this material is given in Table 1.

TABLE 1 - SIEVE ANALYSIS OF ELECTRIC FURNACE GRAPHITE

U. S. No.	Mesh	Per Cent Retained	Cumulative Per Cent	Size (Microns)
50	48	20.2	20.2	297
60	60	10.3	30.5	246
70	65	12.1	42.6	210
80	80	14.9	57.5	175
100	100	12.9	70.4	147
120	115	10.0	80.4	125
140	150	5.2	85.6	104
Pan		14.4	100	

The AFS grain fineness number for this material was calculated to be approximately 80. Common laundry starch in a finely powdered form was used as the green binder. Carbonaceous cement and pulverized pitch provided additional binding strength.

A surface activating agent was mixed with ordinary tap water to act as the vehicle.

The standard mix shown in Table 2 was used to prepare all specimens. Various amounts of water were added to this mixture to provide moisture contents of 4, 5, 6, 8, and 10 per cent by weight.

TABLE 2 — COMPOSITION OF MOLD MATERIAL USED FOR SPECIMEN PREPARATION

Component	Part by Weight
Electric graphite powder AFS No. 80	53
Starch	10
Pitch	10
Carbonaceous cement	8
Surface activating agent	1

SPECIMEN PREPARATION

The total weight of the mixture, excluding the water, was 2.9 kg (6.4 lb). The graphite, starch and pitch were mulled in a 25 lb sand muller for 30 sec. The carbonaceous cement, surface activating agent, and the desired amount of water were then added and the entire mixture was mulled for 2 min. Samples of 100 gr (0.22 lb) were weighed out and pressed into cylindrical specimens. A 2-in. ID steel cylinder of the type employed for making standard sand specimens was used for this purpose. Variations in molding pressure were accomplished by adjusting the applied pressure pneumatically. Pressures of 30.7, 61.5, and 123.0 psi were used for each of the 5 moisture contents.

Nine specimens were made for each combination of moisture content and molding pressure. All of the specimens were air dried for four days. Six out of each group of nine specimens were heated from room temperature to 250 F at a rate of 15 F per hr. These specimens were held at 250 F for six hours and then cooled to room temperature. Three specimens, from each group of six that were baked at 250 F, were placed in a clay graphite crucible, packed with powdered graphite and then fired to 1800 F. These specimens were held at this temperature for two hours and then furnace cooled to room temperature.

TESTING METHODS

Surface Evaluation

Variations in surface finish were observed for the

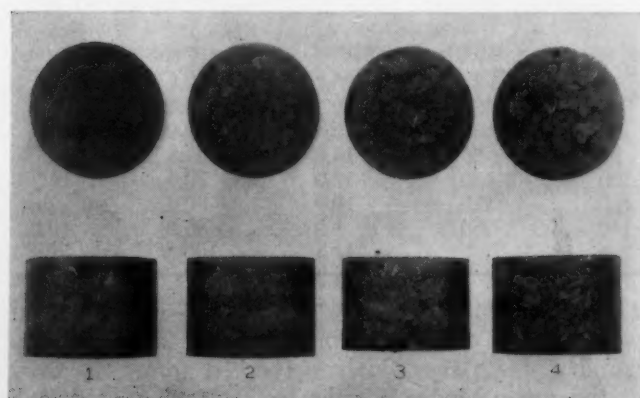


Fig. 1—Surface standards for graphitic mold material.

molded specimens used in this investigation. Therefore, arbitrary standards were established to classify the specimens according to surface appearance. The specimen with the smoothest surface was designated as "1", while the roughest was designated as "4". A photograph of the standards that were assigned surface values of 1, 2, 3, and 4 is shown in Fig. 1. The surfaces of all the specimens prepared in this investigation were evaluated using these standards.

Shrinkage

It was observed that the graphitic material used in this investigation did suffer appreciable shrinkage during baking and firing. This shrinkage can be compensated for by proper pattern design when the degree of shrinkage is accurately known. Therefore, to facilitate accurate pattern design the magnitude of the shrinkage was determined by measuring the diameter of the cylindrical specimens at the various stages of the process.

Compressive Strength

The change in volume which occurs during the solidification of a metal imposes stresses on both the mold and the solid metal. The mold must be strong enough to withstand these stresses. In addition, strong molds are necessary in order to avoid damage due to rough handling.

Compressive strengths for the green (air dried), baked, and fired conditions were determined as a function of water content and molding pressure.

The cylindrical specimens were loaded in compression with a tensile testing machine. The crosshead speed was maintained within the range of 1/10 to 1/20 of an inch per minute. The ultimate compressive strength was calculated by dividing the maximum load by the original cross-sectional area. The tests were run in triplicate for the green and baked states and in duplicate for the fired state.

Permeability

Permeability is the measure of freedom with which the mold material permits gases to pass through it. The gases in the mold may be present from two sources. These are:

- 1) Ambient atmosphere in the mold cavity.
- 2) Generated gas due to mold-metal reaction.

The permeability of the specimens used in this investigation was determined with a commercial testing device. The time was determined for a fixed volume of air (1000 cm³) to pass through the specimen. The absolute permeability was calculated using the formula

$$P = \frac{v h}{p a t}$$

where:

- P = permeability number
- v = volume of air passing through specimen (1000 cm³)
- h = height of specimen (cm)
- p = pressure of the air (10 gr/cm²)
- a = cross-sectional area of specimen (cm²)
- t = time (minutes) for 1000 cm³ of air to pass through specimen

Thermal Conductivity

Molten titanium will react with graphite. However, if graphite is used as a mold material there is practically no carbon pick-up from the mold because the metal is chilled very rapidly. This chilling action of the mold causes the resulting casting to have a rippled surface. The rippled surface condition can be minimized if the molten metal is superheated appreciably. By reducing the thermal conductivity of a graphitic-type mold the amount of superheat necessary to obtain smooth castings would be reduced. However, the thermal conductivity of the mold should be maintained at some minimum value to prevent detrimental carbon pick-up. The specimens used in this investigation were a mixture of graphite, carbon and voids. Therefore, mold conductivity largely should be a function of the void content, which in turn is dependent upon the molding pressure and moisture content. In order to determine the relative effect of molding pressure and moisture content on the thermal conductivity of the material, the following method was employed:

A fired cylindrical specimen of each moisture content and molding pressure was ground to a height of 1-1/4 in. A 1/8-in. diameter hole was drilled 1/4-in. deep in the center of one of the circular faces of each specimen. Thermocouples were cemented into these holes with carbonaceous cement. Five of these specimens and a machined graphite control specimen were rammed up in a sand mold

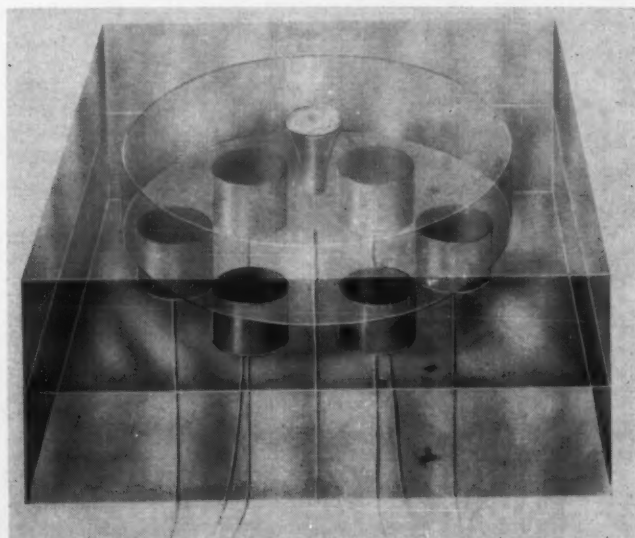


Fig. 2—Aluminum casting and mold, showing specimen and thermocouple arrangement used to determine heating curves for thermal conductivity calculations.

as shown in Fig. 2. Molten aluminum was cast into the mold and heating curves were obtained for each specimen. In addition, the temperature at the aluminum-sand mold interface was recorded as a function of time. The conductivity of each specimen was calculated from these data. A sample calculation is given in Appendix I.

Surface Contamination

Numerous materials have been tested as molds for casting titanium. Practically all of them have been

rejected because they react with titanium and form brittle contaminated surfaces on the casting. The microhardness traverse has been used extensively in identifying the presence of such a surface. This test reveals both degree and depth of contamination. The degree and depth of contamination associated with the various specimens used in this investigation were determined by casting unalloyed titanium (Bhn 120) around the specimens as shown in Fig. 3. A control specimen of machined graphite was used for each casting. The castings were sectioned and microhardness traverses were made. A graph was then

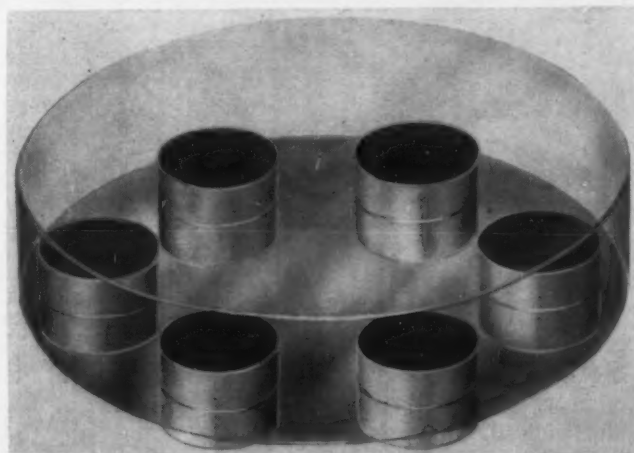


Fig. 3—Titanium casting used for contamination measurements, showing arrangement of graphitic specimens.

plotted of the hardness versus the perpendicular distance of the hardness reading from the mold-metal interface. All of the castings were made in a non-consumable electrode arc-type bottom pour melting furnace.⁴

Mold Penetration

The high fluidity of molten titanium facilitates the penetration of the molten metal into the interstices of permeable molds. Mold penetration of this type would occur at corners and edges of core where hot spots would be prevalent.

Mold penetration of the specimens used in this investigation was determined by visual observation of the titanium castings.

TEST RESULTS

Surface Evaluation

The data in Table 3 represent the average of three separate evaluations of the surface appearance of the various specimens. The ratings given in this table are

TABLE 3 — SURFACE RATING OF GRAPHITIC MOLD MATERIAL SPECIMENS FOR VARIOUS WATER CONTENTS AND MOLDING PRESSURES

Per Cent Water	Surface Rating*		
	Molding Pressure (psi)		
	30.7	61.5	123.0
4	1.50	1.25	1.00
5	1.75	1.25	1.00
6	2.25	1.50	1.25
8	2.75	1.75	1.50
10	4.00	2.50	2.00

*Average of 3 evaluations

based on the standards shown in Fig. 1. The data in Table 3 indicate that smoother surfaces are obtained by increasing the molding pressure and decreasing the moisture content. At the higher moisture contents, the molding material had a tendency to "ball" in the muller. It was this balling or lumpiness that caused the rough surface appearance in the higher moisture content specimens.

TABLE 4 — MOLD SHRINKAGE OF GRAPHITIC MOLD MATERIAL FOR VARIOUS WATER CONTENTS AND MOLDING PRESSURES.

Per Cent Water	Shrinkage* (in./ft)		
	Molding Pressure (psi)		
	30.7	61.5	123.0
4	0.367	0.313	0.300
5	0.331	0.301	0.270
6	0.338	0.289	0.310
8	0.326	0.302	0.265
10	0.290	0.291	0.265

* Average of three tests.

Shrinkage

The average mold shrinkage for the various moisture contents and molding pressures are listed in Table 4. These data illustrate a general trend of decreasing shrinkage with increasing moisture content and molding pressure. Although the higher moisture content material did tend to ball in the muller, it was more plastic. This plasticity enabled the particles to be more closely packed.

This closer packing was reflected in increased density as shown in Table 5, and this closer packing accounts for the reduced amount of shrinkage.

TABLE 5 — DENSITY OF GRAPHITIC SPECIMENS IN THE BAKED CONDITION

Per Cent Water	Density of Baked Specimens (g/cc)		
	Molding Pressure (psi)		
	30.7	61.5	123.0
4	1.03	1.10	1.20
5	1.03	1.10	1.17
6	1.08	1.15	1.25
8	1.14	1.26	1.36
10	1.19	1.26	1.35

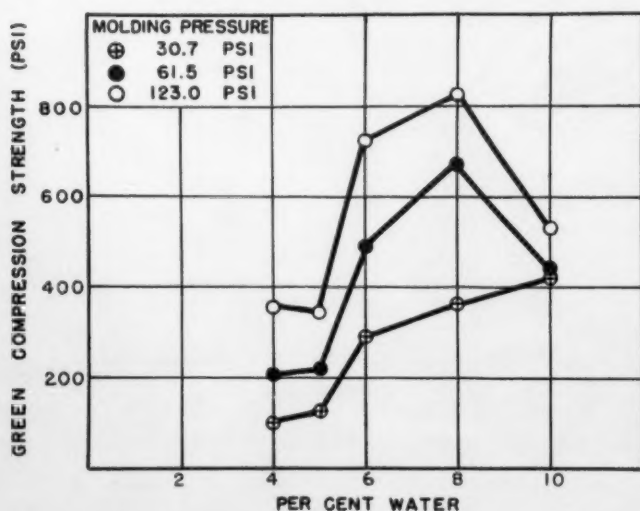


Fig. 4—Green compression strength vs per cent water for graphitic mold.

Compression Strength

The compression strengths vs per cent water for the green, baked, and fired conditions are shown in Fig. 4, 5 and 6, respectively. In Fig. 4 it can be seen that with molding pressures of 61.5 and 123.0 psi, maximum strength is obtained with approximately 8 per cent water. At the lower molding pressure (30.7 psi) no maximum strength is observed for up to 10 per cent water. The lowest compression strength ob-

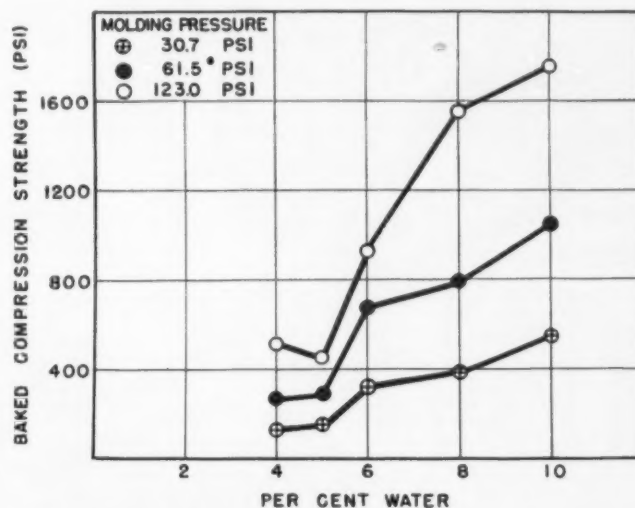


Fig. 5—Baked compression strength vs per cent water for graphitic mold material.

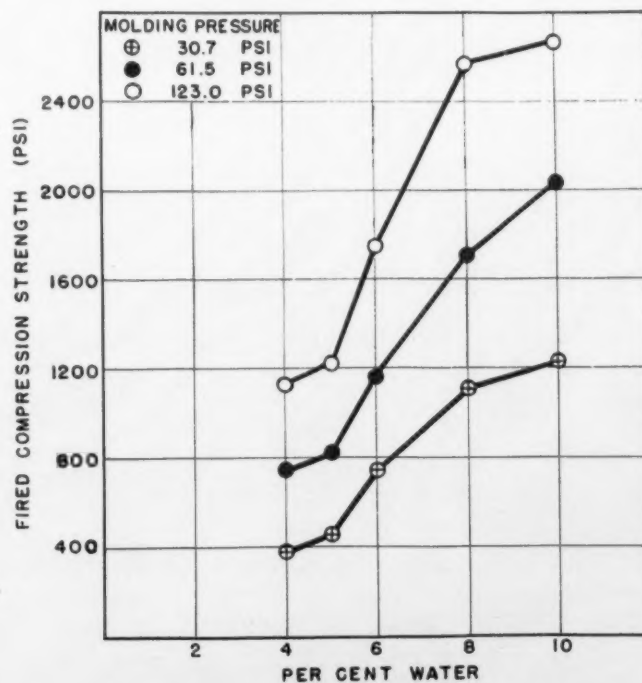


Fig. 6—Fired compression strength vs per cent water for graphitic mold material.

tained in the green state is approximately 100 psi (4 per cent water, 30.7 psi molding pressure). Comparing Fig. 4 and 5, it can be seen that the baking treatment has a greater effect on the strength of the higher moisture content material, especially at the higher molding pressures. However, baking did increase the strength of all specimens appreciably.

In Fig. 6 fired compression strength is plotted. It can be seen by comparing these curves with those of Fig. 4 and 5 that firing imparts even greater strength to the mold material. In Fig. 7 the effect of molding pressure on the fired compression strength is shown for constant moisture contents. In all cases, the strength increases appreciably as the molding pressure is increased. The actual compression strength data for all three states of the material are listed in Appendix II.

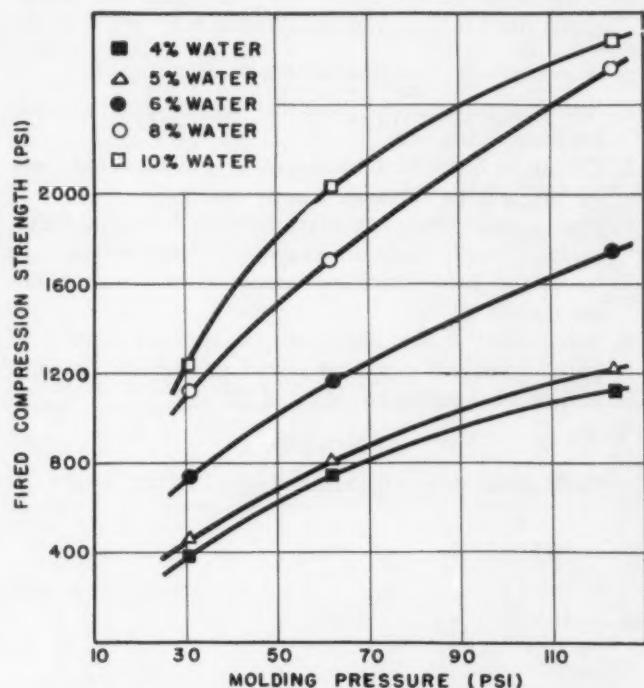


Fig. 7—Fired compression strength vs molding pressure for graphitic mold.

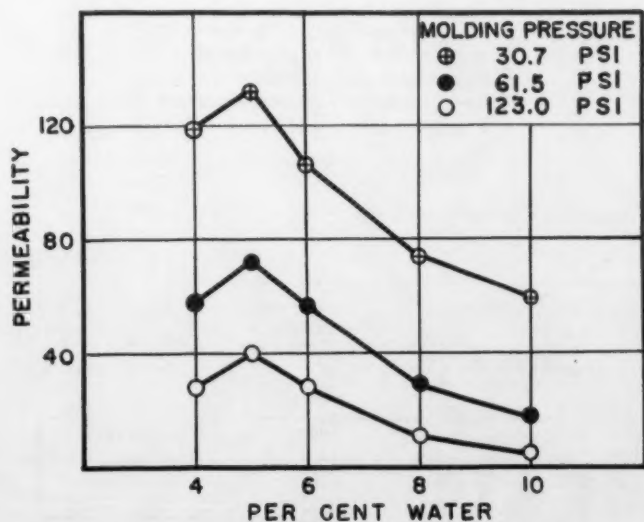


Fig. 8—Permeability vs per cent water for graphitic mold material.

Permeability

The average permeability vs moisture content is plotted for each molding pressure in Fig. 8. It can be seen from these plots that the permeability decreases with increasing water content and increasing molding pressure. The actual permeability data are listed in Appendix III.

Thermal Conductivity

Approximate thermal conductivities for the various water contents and molding pressures are shown in Table 4. It can be seen from this table that the conductivity varied from approximately 4 to 10 Btu/hr ft °F as the water content and molding pressure were increased. An increase in molding pressure or water content increases the conductivity.

TABLE 6 — THERMAL CONDUCTIVITY OF GRAPHITIC MOLD MATERIAL FOR VARIOUS WATER CONTENTS AND MOLDING PRESSURES

Per Cent Water	Thermal Conductivity Btu/hr ft °F		
	Molding Pressure (psi)		
	30.7	61.5	123.0
4	4.1	4.3	5.3
5	4.2	4.6	5.5
6	4.3	5.3	6.6
8	6.4	7.8	9.1
10	7.0	9.6	9.7

Surface Contamination

Figure 9 is a plot of Knoop hardness numbers vs distance from the mold-metal interface. Two bands are plotted in this figure. The hatched band represents the variation in hardness that was obtained for three castings made against machined graphite specimens.

The unhatched band represents the same property with the graphitic mold material specimens. The maximum variation of hardness for the graphitic specimens is approximately 120 Khn units. A comparison of the upper limit of this band with the band for the machined graphite specimens indicates an appreciable degree of contamination. It should be emphasized, however, that for every water content there was at least one molding pressure (almost exclusively the

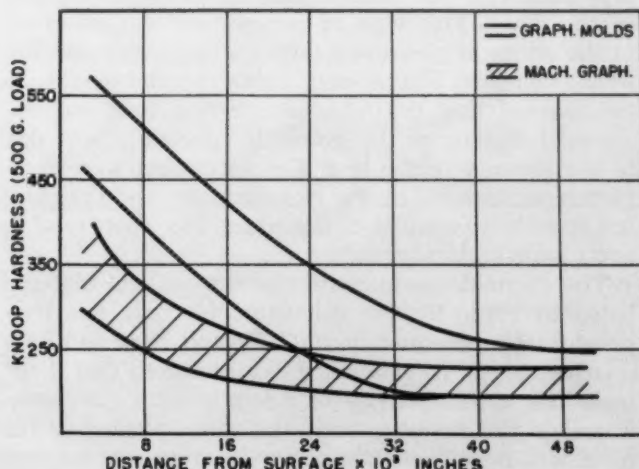


Fig. 9—Knoop hardness vs distance into metal from mold-metal surface.

highest molding pressure) which gave a curve practically coincident with the lower limit of the unhatched band in Fig. 9. The lower part of the unhatched band in Fig. 9 compares favorably with the machined graphite mold data (hatched band). The actual hardness data are listed in Appendix IV.

Mold Penetration

It was observed that the molten titanium penetrated the edges of several specimens and produced a spongy mass of metal at the edges. The degree of edge penetration was greatest for the 4 per cent water specimen that was molded at the lowest pressure. The degree of edge penetration decreased as the water content and molding pressure were increased. Table 7 lists the specimens which exhibited evidence of edge penetration.

TABLE 7 — EDGE EFFECT OF MOLTEN TITANIUM ON GRAPHITIC MOLD MATERIAL FOR VARIOUS WATER CONTENTS AND MOLDING PRESSURE

Per Cent Water	Edge Effect (N or P)*		
	Molding Pressure (psi)		
	30.7	61.5	123.0
4	P	P	P
5	P	P	N
6	P	P	N
8	P	P	N
10	P	N	N

*P = penetration at edges

N = No penetration

DISCUSSION

These data illustrate that expendable molds with smooth surfaces can be made with a graphitic material. Variation of the distribution and size of graphite particles can offer a means of obtaining mold surfaces even smoother than those obtained in this investigation. Shrinkage values have been obtained so that proper pattern sizes can be determined when the graphitic material is used to make molds. Green strength is sufficient to facilitate easy handling of molds made from this material.

The question of mold permeability for titanium casting is important because of the capillary action or penetration of the molten metal into the interstices of the mold. This type of penetration was observed at the edges of specimens with the higher permeabilities (compare Fig. 8 and Table 7). It should be emphasized that the edge penetration that was observed for some of the graphitic specimens was due to the severity of the test. The specimens were completely surrounded by the cast titanium, and therefore hot spots were created at the edges. Hot spots tend to accentuate mold penetration.

The thermal conductivities of the molded material listed in Table 6 were calculated for only one temperature (approximately 1000 F) and represent only relative values. In general, it can be stated that if the mold has a conductivity of 5.3 or greater (as determined in this investigation) the chilling effect of the mold will be sufficient to prevent serious surface contamination of the titanium. Edge or corner penetration might occur if the permeability is too high.

Figure 9 illustrates that molds can be made which closely approach the performance of machined graphite molds, with respect to extent of surface contamination of the cast titanium.

Additional work at Frankford Arsenal has led to the establishment of a procedure for making molds of complex shapes. The procedure utilizes common foundry techniques and equipment. This technique,

when used with the graphitic material described in this paper, yields molds which are suitable for the casting of titanium. The procedure for preparing molds is given in Appendix V.

ACKNOWLEDGMENTS

The authors wish to express their appreciation to H. Markus, Director, Metallurgical Research Laboratory, and S. Lipson, Chief, Foundry Research Branch, Pitman-Dunn Laboratories, for providing the assistance required in carrying out this study.

CONCLUSIONS

- 1) Suitable expendable graphitic molds can be made for casting titanium.
- 2) Common foundry techniques and equipment may be utilized to fabricate these molds.
- 3) The permeability, strength, thermal conductivity, surface finish and shrinkage of these molds can be varied by controlling water content and molding pressure.
- 4) Satisfactory molds for casting titanium can be prepared from a 6 per cent water mixture by using a minimum molding pressure of 100 psi.

APPENDIX I

CALCULATIONS OF THERMAL CONDUCTIVITY

$$q_1 = K_1 A \frac{t_m - t_1}{x_2 - x_1}$$

$$q_2 = K_2 A \frac{t_m - t_2}{x_2 - x_1}$$

Where:

q_1, q_2 = rate of heat flow

K_1 = thermal conductivity of machined graphite

K_2 = thermal conductivity of mold material

t_m = temperature (F) of mold surface in contact with aluminum

A = cross-sectional area of specimen (ft)²

t_1 = temperature (F) of machined graphite 1 in. from metal-mold interface

t_2 = temperature (F) of carbonaceous mold material 1 in. from metal-mold interface

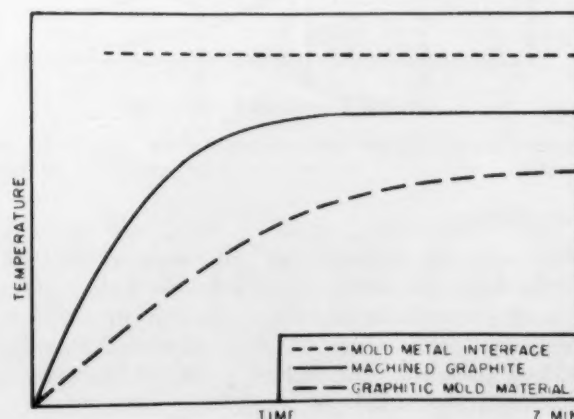
$x_1 = 0$

$x_2 = \frac{1}{12}$ ft

Assuming that $q_1 = q_2$ then:

$$K_1 A \frac{t_m - t_1}{x_2 - x_1} = K_2 A \frac{t_m - t_2}{x_2 - x_1}$$

$$K_2 = K_1 \frac{t_m - t_1}{t_m - t_2}$$



From the preceeding set of curves it can be seen that after seven minutes there is very little change of temperature with time. Therefore, a first approximation of the thermal conductivity of the graphitic mold material can be made by employing the steady state conduction heat flow equation modified to:

$$K_2 = K_1 \frac{t_m - t_1}{t_m - t_2}$$

Unidirectional heat flow parallel to the cylindrical axis of symmetry is encouraged by the insulating characteristics of the sand packed around the cylindrical surfaces of the specimens.

APPENDIX III PERMEABILITY OF FIRED SPECIMENS

Per Cent Water	Permeability Number*		
	Molding Pressure (psi)		
	30.7	61.5	123.0
4	118.2	58.0	28.1
5	131.8	72.0	39.7
6	106.0	56.5	28.3
8	74.0	29.3	11.3
10	59.5	18.1	5.3

*Average of duplicate tests on each of three specimens.

APPENDIX II COMPRESSION STRENGTH OF GRAPHITE MOLDS

Per Cent Water	Green State		
	Stress (psi)*		
	Molding Pressure (psi)		
	30.7	61.5	123.0
4	100	210	365
5	120	220	340
6	290	490	725
8	365	625	830
10	420	440	530
	Baked State		
4	135	270	510
5	150	290	450
6	335	680	930
8	385	790	1555
10	560	1060	1760
	Fired State		
4	380	745	1130
5	455	820	1230
6	745	1165	1750
8	1110	1705	2565
10	1235	2040	2685

*Average of three tests for green and baked and two tests for fired state.

APPENDIX IV KNOOP HARDNESS (500 G LOAD) VS DISTANCE FROM MOLD-METAL INTERFACE FOR SPECIMENS OF VARIOUS MOISTURE CONTENT AND MOLDING PRESSURE

Per Cent Water	4			5			6		
	30.7	61.5	123.0	30.7	61.5	123.0	30.7	61.5	123.0
Molding Pressure	Knoop Hardness* (500 g load)								
Dist. from Interface									
0.002 inch	560	533	472	465	390	498	521	510	448
0.004 inch	494	518	470	525	420	460	502	499	453
0.006 inch	512	490	420	538	435	463	502	485	463
0.008 inch	510	499	453	510	390	497	454	418	438
0.010 inch	518	469	418	499	431	467	390	396	373
0.012 inch	480	441	374	405	408	403	444	386	352
0.014 inch	425	333	363	415	382	351	405	373	370
0.018 inch	360	344	340	402	324	367	335	326	347
0.022 inch	309	293	318	405	299	336	297	324	318
0.026 inch	275	313	293	315	323	298	305	324	285
0.030 inch	238	236	263	275	266	254	245	285	232
0.034 inch	222	201	245	320	274	236	251	260	235
0.038 inch	221	225	218	291	248	218	243	247	222
0.042 inch	222	245	193	291	238	196	170	210	224
0.046 inch	—	243	190	245	221	193	170	219	223
0.250 inch	221	210	160	242	—	205	198	193	190
0.500 inch	—	—	—	245	235	—	174	195	205

*Average of two readings.

Per Cent Water	8			10			Machined Graphite		
	30.7	61.5	123.0	30.7	61.5	123.0			
Molding Pressure	Knoop Hardness (500 g load)								
Dist. from Interface									
0.002 inch	570	530	433	465	512	538	285	313	281
0.004 inch	494	506	458	422	547	506	295	378	305
0.006 inch	494	480	451	454	510	430	287	373	295
0.008 inch	469	469	428	490	454	465	281	291	309
0.010 inch	375	448	367	451	494	378	288	301	311
0.012 inch	370	418	362	428	384	339	250	293	256
0.014 inch	305	398	375	378	353	367	263	281	238
0.018 inch	305	386	299	303	248	330	250	289	218
0.022 inch	270	346	279	318	299	283	266	248	192
0.026 inch	247	339	277	253	266	318	209	238	208
0.030 inch	235	309	303	244	309	245	240	230	214
0.034 inch	188	291	234	248	243	209	228	233	194
0.038 inch	156	251	219	207	268	210	233	238	202
0.042 inch	142	243	211	219	251	188	215	235	200
0.046 inch	135	233	198	210	258	185	—	222	208
0.250 inch	185	202	204	190	250	180	180	224	219
0.500 inch	—	—	230	—	234	220	—	248	180

APPENDIX V **PROCEDURE FOR PREPARING RAMABLE GRAPHITIC MOLDS**

- 1) Weigh out the constituents shown in Table 2 in the proper proportions.
- 2) Mull the dry constituents for approximately 30 seconds in a clean sand-type muller.
- 3) Mix the carbonaceous cement, surface activating agent and sufficient water in a separate vessel. From this investigation it has been found that 6 per cent water is optimum.
- 4) Add the mixture of the cement, surface activating agent, and water to the dry constituents and mull the entire mixture approximately three minutes.
- 5) Coat the pattern and inside of the flask with a suitable parting agent, such as a silicone spray.
- 6) Pack the graphitic mold material around the pattern by conventional hand ramming techniques until the flask is full.
- 7) The finish molding operation should be accomplished by jolting and squeezing. A minimum pressure of 100 psi should be applied to the mold during the squeezing operation.
- 8) Remove the pattern and the flask. Then dry, bake and fire the mold using the procedure outlined

in this report. Accelerated drying from the green state will rupture the mold.

Note:

1. Excessive quantities of the mold material should not be muller up at one time since the material sets up and becomes difficult to work. Set-up time for a 6 per cent water mix is approximately one hour.
2. Gates and risers can be cut into the mold easily after the baking process.

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This paper has been approved for presentation at the 62nd Annual Meeting of the American Foundrymen's Society, to be held in Cleveland, Ohio, May 19-23, 1958. The Society reserves all rights for publication either prior to or subsequent to presentation, and is not responsible for statements or opinions advanced herein.

WRITTEN DISCUSSION IS SOLICITED

SOME REQUIREMENTS FOR SUCCESSFUL FLUIDITY TESTING

By

S. A. Prussin* and G. R. Fitterer**

ABSTRACT

The major limitation to the use of fluidity testing as a means of controlling metal quality in the foundry has been the lack of reliability of the results. This investigation has uncovered two sources for this. One is the variation in the velocity of the stream of molten metal as it enters the flow channel of the fluidity mold. A new fluidity tester (fluidimeter), designed to insure reproducible metal flow, is described.

The second cause of variability lies in the mechanism of flow cessation of the fluidity test. Means of improving the reliability of the test by adjusting the physical dimensions of the test mold are discussed.

Techniques to determine the actual rate of flow of the molten metal stream within the fluidity test mold were developed. This data gives further insight into the mechanism of the fluidity test.

INTRODUCTION

Attempts to devise a method of measuring the ability of molten metal to fill a mold were made as early as 1898.¹ The development, however, of the modern design which measures the fluidity of molten metal by the length of the runner cast under fixed conditions in a closed channel of constant cross sectional area did not evolve until two decades later. In Japan,² France³ and Germany,⁴ within the space of a few years, investigations were undertaken using such molds. This basic design, with various modifications, has been retained to the present. A. I. Krynitsky's⁵ comprehensive review is recommended to those interested in the development of fluidimeter design.

The property of fluidity, as expressed directly by some of the previous investigators, is implicit in all these fluidimeter designs. Molten metal under a given pressure, produced either by its own static pressure,

the inertia of pouring, or a combination of these, is caused to flow down a closed channel of constant cross section. This channel, which may be straight or spiral, lies in the horizontal plane. As the metal stream flows down the channel, it is continuously cooled until stopped by the obstruction of solidified metal. The fluidity of the molten metal is given by the length of the rod cast in the specific test mold being used.

Many investigators have listed the variables important in determining the fluidity length for molten metals. Although there is disagreement as to their relative importance, all variables fall into three groups. First are the variables of the metal, such as oxide films, pouring temperature, and composition. Second are the variables of the test mold, including the shape and cross sectional area of the flow channel, the mold material and the gating arrangement. Third is the variable of the human element, consisting primarily of the effect on fluidity of the manner in which the molten metal is poured into the test mold.

For a successful plant fluidimeter, the variable of the human element must be effectively eliminated. This was successfully accomplished by the reservoir fluidimeter design developed by the author. Further investigation showed that, for duplicate metal and mold conditions, differences in metal fluidity length could still be obtained. These are attributed to the mechanism of freezing of the fluidity rod and means to reduce these variations even further are indicated.

INITIAL INVESTIGATION

The many available fluidimeter designs led the author to begin this study with an Acid Open Hearth Research Association slag fluidimeter, Fig. 1. This design had been found to give consistent results by different operators for an entire series of mills⁶. It was, in addition, quite similar in design to the Ruff metal fluidimeter, which was the source of an extensive theoretical study⁷.

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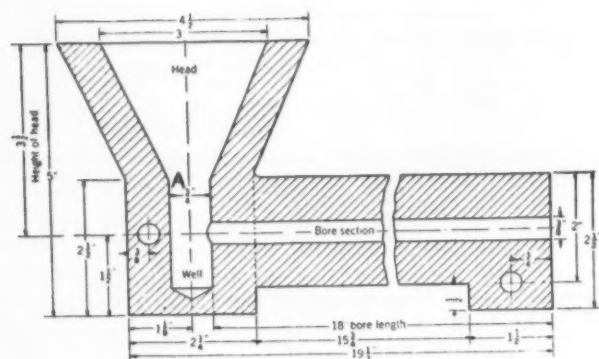


Fig. 1—Acid Open Hearth Research Association slag fluidimeter.

Duplicate tests were performed with identical A.O.-H.R.A. fluidimeter molds on the same acid steel heat in the interval between blocking and tapping. These showed a much greater variation than had similar tests performed for slag with the same mold.

Possible differences in the mechanism of flow between slag and metal were investigated in the following experiment. The A.O.H.R.A. fluidity mold halves were shimmed with strips of sheet metal, 0.010 in. thick, so that the light given off by the incandescent metal stream could be seen through the vertical split. The movement of the stream was recorded by a hand wound movie camera, mounted vertically above the mold and focused on the split. A series of metal fluidity tests were poured by the same operator who attempted to pour each test identically.

The developed film was viewed frame by frame on the large viewing glass of a microprojector, and

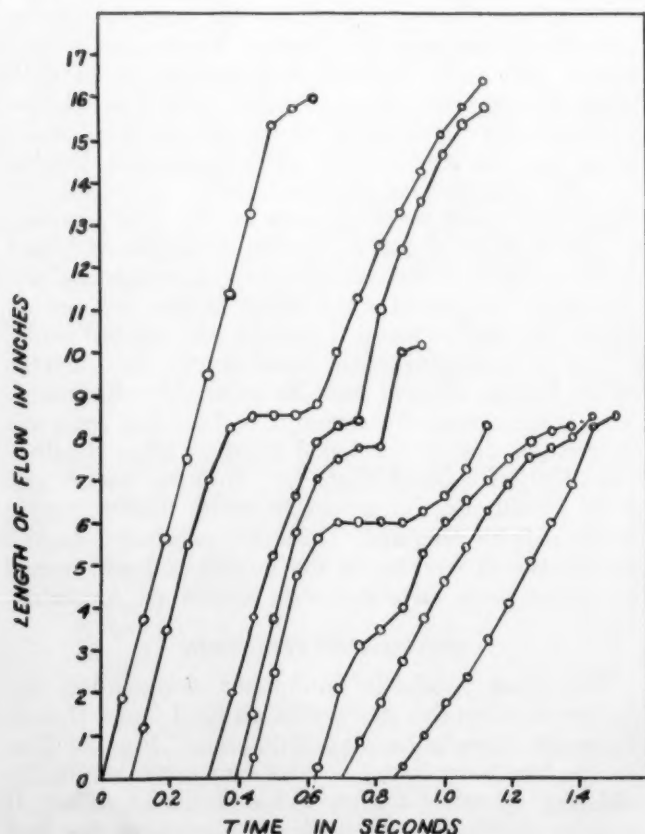


Fig. 2—Flow curves obtained for steel with the A.O.H.R.A. fluidimeter.

the length of the stream of white hot metal was measured. An identical experiment was also performed for slag. Eight representative metal fluidity flow curves are shown in Fig. 2.

The results of this preliminary study may be summarized as follows:

- 1) The duration of metal fluidity flow was about 3/4 of a second for this fluidimeter.
- 2) There was no consistent pattern of flow.
- 3) The maximum velocity during flow corresponded to less than 1.35 in. of head on the basis of the relation $V^2 = 2gH$, while the nominal metallostatic head was 3.5 in.
- 4) While the metal stream completed its flow in less than a second, motion was still discernable in the slag stream after twenty seconds of flow.

The two conclusions drawn from this preliminary investigation were:

- 1) The mechanism of flow of molten metal through a fluidity mold is radically different from that of slag.
- 2) The rate of metal flow through a fluidimeter is so rapid that any design which allowed metal to run into the flow channel while the operator was filling the pouring cup would result in magnifying the human variable in fluidity testing.

Among the multitude of metal fluidimeter designs proposed in the past three decades, a few have satisfied the criterion that the pouring cup be completely full before flow down the flow channel began. To the author's knowledge, no plant fluidimeters in present use satisfy this criterion.

FUNDAMENTAL DESIGN OF FLUIDIMETERS

The fluidimeter mold can be considered to consist of two parts, each with a separate and distinct function. One part is designated as the head, the other as the flow channel. The function of the head is to deliver molten metal to the flow channel under a fixed pressure and to maintain this pressure during the course of metal flow. The flow channel of constant cross section extracts heat from the flowing metal stream, finally bringing it to rest by causing solidification across its cross section.

Control of the human variable would appear to depend on head design. For a head to deliver molten metal at constant pressure it would have to satisfy the criterion of flow only under full static head. Three possible fluidimeter designs which satisfy this criterion were investigated with respect to their use for plant work. These designs were:

- 1) Fusible plug fluidimeter.
- 2) Stopper rod fluidimeter.
- 3) Reservoir fluidimeter.

Fusible Plug Fluidimeter

Portevin and Bastien⁸ used a lead cap to retard flow from the head to the flow channel in their investigation of the fluidity of low melting non-ferrous alloys. To avoid the problems of contamination, sheet metal cups of approximately the same composition as the metal being tested were forced into an A.O.H.R.A. mold at point A, Fig. 1. Identical results were experienced with both molten steel and aluminum. Starting with thin gage sheet, it was found that the molten metal passed from the head to the flow channel

without any measurable retardation. As the thickness of the cups was increased, there was no increase in retardation until a critical sheet thickness was reached. For this and greater sheet thicknesses, no flow occurred at all, the molten metal solidifying in the head. To reduce the rate of heat transfer from the molten metal to the metal cups, these were coated with non-reactive inorganic salts. This proved ineffective.

Stopper Rod Fluidimeter

Retardation of flow can be simply obtained if the opening from the head to the flow channel is closed by a stopper rod. The rod can then be lifted to release the molten metal when the head well is full. Such a design was used by Saito and Hayashi² for brass, bronze, lead and aluminum and by Halliwell⁹ for brass. In both cases, the investigators used a preheated stopper rod.

Tests carried out on molten aluminum with an A.O.H.R.A. mold converted to a stopper rod fluidimeter verified the necessity of preheating the stopper rod. Otherwise solidification occurred on the cold stopper rod, as metal was poured into the head well. The necessity of preheating the stopper rod and the difficulty of finding a design that might be easily and safely operated led to the abandonment of this fundamental design for plant work.

Reservoir Fluidimeter

The criterion of a satisfactory mold can be met if the fluidimeter design includes a reservoir which connects the pouring head to the flow channel, Fig. 3.

As the liquid metal is poured into the head well A, some of it runs out of the orifice tube B into the reservoir C. Before flow can begin down the flow channel D, the reservoir must be filled. For any specified rate of pour into the head well and for a given size orifice, it is possible to calculate the volume of a reservoir that will just be filled as the molten metal reaches the top of the head well. Flow would then take place under the static pressure corresponding to a full head well.

For a rate of pour greater than that specified, the head well will be filled before the reservoir, and flow under full static head can be obtained by then keeping the head well full. Thus, on the basis of a minimum rate of pour, a successful reservoir fluidimeter may be designed. The requirements for the operator are simply that he fill the head well rapidly and then keep it full. One practical limitation in the design of a plant fluidimeter is the amount of molten

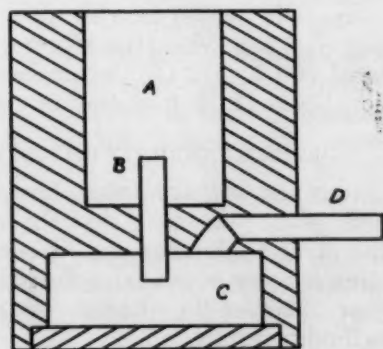


Fig. 3—Reservoir fluidimeter design.

metal which a standard spoon will hold. Another is the lowest rate above which an operator can be safely expected to pour the metal into the fluidimeter. In the appendix, calculations of the combinations of static head, channel cross sectional area, reservoir volume, and orifice diameter consistent with these two limitations are illustrated.

LABORATORY INVESTIGATION

Flow curves for a reservoir fluidimeter were obtained under the more carefully controlled conditions available in the laboratory. These were compared to flow curves obtained from a stopper rod fluidimeter which unquestionably satisfied the criterion of flow under a full head.

Both fluidimeters used the same flow channels. The



Fig. 4—Laboratory stopper rod fluidimeter head (cross section).

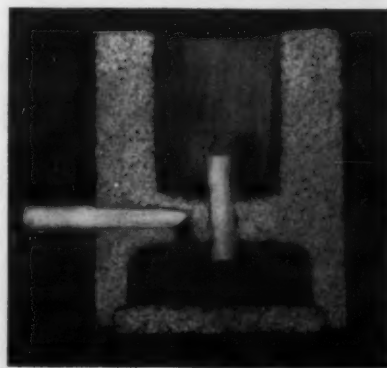


Fig. 5—Reservoir fluidimeter head (cross section).

heads, Figs. 4 and 5, were constructed from porous refractory brick and internally coated with alumina cement. The orifices and connections to the flow channel were made from ceramic tubes. The flow channel was formed by two steel bars, ground flat, and milled down their length with a semicircular cutter. The bars were pinned together to form a circular flow channel, and slipped over the exit tube of the head. Clamps were used to hold the flow channel horizontal. Two sets of flow channel bars are shown in Fig. 6.

The metal used in the laboratory investigations,

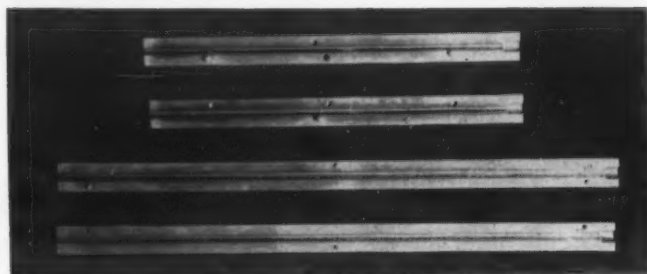


Fig. 6—Two sets of flow channel bars.

electrolytically refined zinc, was chosen for its ease of use with the available melting equipment. Since zinc is not incandescent in its liquid state, as was steel, its flow behavior was measured by its ability to block light rather than give it off. This light was provided by a fluorescent lighting tube. The two pinned bars forming the flow channel were separated by a gap of 0.010 in. through the use of shims at both ends. A precision electrically driven movie camera was focused through this gap on the fluorescent lighting tube beneath. At a speed of 4000 frames per minute it was possible to record the laboratory runs adequately.

The developed film was examined frame by frame on a microprojector and the length of the illuminated flow channel was measured. Figure 7 is an enlarged print of a single 16 mm frame taken before flow began. The empty, but illuminated, flow channel appears as a horizontal line, broken by the presence of three pins. As flow occurs, the length of this line decreases



Fig. 7—Single frame of film taken of flow channel, enlarged.

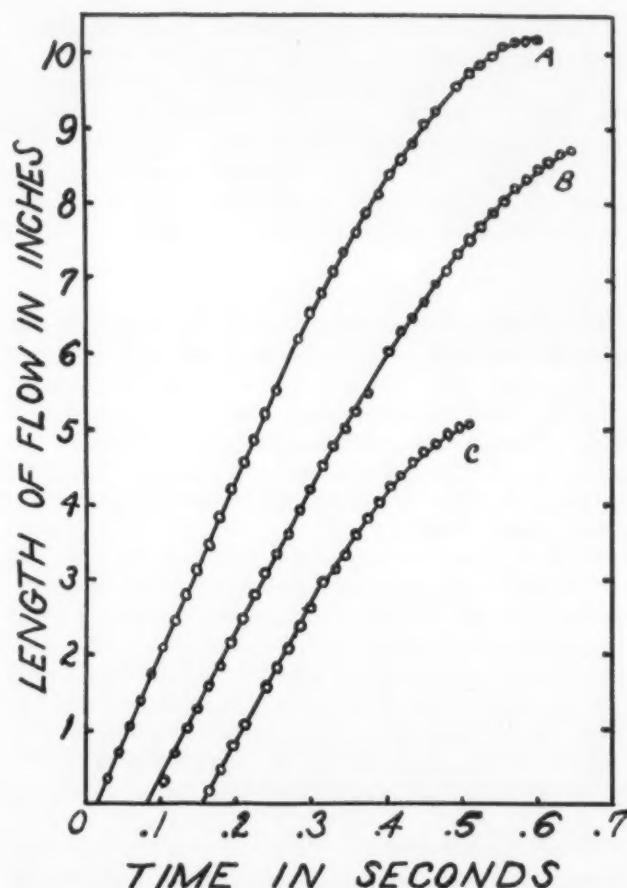


Fig. 8—Typical fluidity flow curves obtained with laboratory stopper rod and reservoir fluidimeters.

from frame to frame, the decrease being equal to the length of flow of metal in the channel. The surface tension of the molten zinc was sufficient to prevent the escape of metal through the 0.010 inch gap. In fact, for very few of the tests run was any flash formed.

Figure 8 illustrates the fluidity flow curves obtained by this technique. The curves marked A and B were obtained with stopper rod fluidimeters, A with a metalostatic head of 3.5 in. and B with one of 2.5 in. Curve C was obtained with a reservoir fluidimeter with a metalostatic head of 2.25 in. For all three runs, a metal temperature of 990 F (532 C) and a 3/16-in. flow channel were used.

The shorter fluidity run for the reservoir mold was due not only to the lower initial flow channel velocity but also to the loss of some of its heat content to the ceramic head before reaching the flow channel. While the molten metal was poured into the reservoir mold at 990 F (532 C) that for the stopper rod fluidimeter was poured into the head well 150 F (83 C) higher. Then when the thermocouple, Fig. 4, registered 990 F (532 C), the stopper rod was lifted and flow began at this temperature.

REPRODUCIBILITY OF THE FLUIDITY TEST

It is the author's belief, based on limited contact with plant personnel, that the normal variability of the plant fluidimeter was its severest limitation. The large number of available fluidimeter designs also appear to reflect the attempts to reduce this variability in fluidity results.

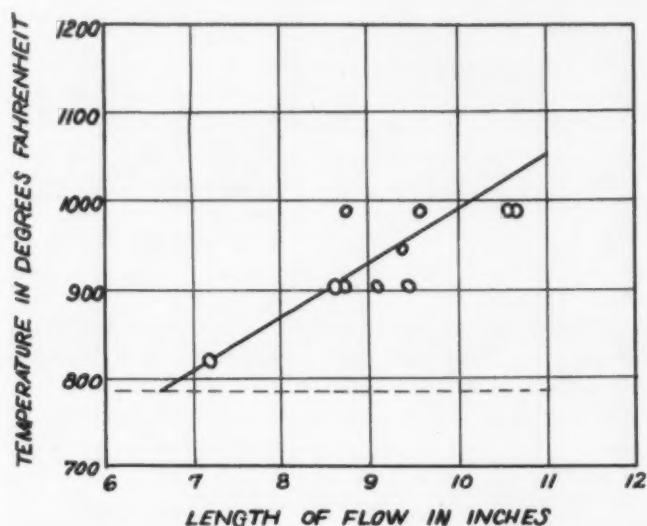


Fig. 9—The effect of temperature on the fluidity of molten zinc as determined by a stopper rod fluidimeter with a 2-1/2-in. static head and a 3/16-in. diameter split bar flow channel.

The laboratory stopper rod technique, providing an accurate control of both metal temperature and metal velocity at the entrance to the flow channel appeared to be an excellent means to determine whether such variations were intrinsic in the very mechanism of fluidity testing or were simply due to testing variables. Table 1 contains the results of ten fluidity tests while Fig. 9 is a plot of part of this data. It was apparent that the variations in initial metal velocity have not caused the considerable scatter shown in Fig. 9. Test R-3 for example, had a shorter fluidity length than test R-2 even though its initial velocity was greater, the temperature being identical for both runs. It thus appeared that fluidity variability was affected by at least one factor other than the human element.

MECHANISMS OF FLOW CESSATION

From the fluidity flow curves in Fig. 8, it can be seen that the molten metal flows down the flow channel at a constant velocity for a given distance and then begins a progressive deceleration that can be explained only as the beginning of solidification.

It has been suggested by Portevin and Bastien¹⁰ that such solidification occurs by the precipitation of a fine shower of crystals within the metal stream and that this precipitation progressively slows down the stream by increasing the effective viscosity. Lips and Nipper¹¹ carried out an investigation on the effect of particles of different sizes and shapes in a liquid on its viscosity. In addition, they studied the fluidity of an aqueous solution of potassium nitrate in a glass tube flow channel and showed that solidification of this liquid occurred by fine particle precipitation. They found that the resulting increased viscosity brought the stream to rest when only a fraction of the liquid had solidified.

This mechanism is rejected for metals for the following reasons:

1) As Desch¹² pointed out, the formation of fine precipitates occurs only for materials which can undergo severe undercooling, which is not true for metals.

TABLE 1—CHARACTERISTICS OF TEN FLUIDITY TESTS

Stopper Rod Fluidimeter, 2-1/2 in. Static Head, 3/16-in. Diameter Flow Channel			
Test No.	Initial Flow Velocity in./sec.	Casting Temp. F (C)	Length of Flow in.
R-1	21.95	820 (438)	7-3/16
R-2	20.55	905 (485)	9-1/16
R-3	23.55	905 (485)	3-5/8
R-4	24.20	905 (485)	9-7/16
R-5	24.25	905 (485)	8-11/16
R-6	24.50	947 (497)	9-3/8
R-7	21.60	990 (532)	10-9/16
R-8	24.65	990 (532)	10-5/8
R-9	22.95	990 (532)	9-9/16
R-10	20.00	990 (532)	8-3/4

2) The high rate of cooling of the molten metal and the accompanying steep temperature gradient would favor solidification at the flow channel surfaces.

3) Examination of the cross section of the cast fluidity rod shows a columnar structure with the columnar grains originating at the flow channel surface.

The author suggests that solidification begins in the coldest part of the metal stream, the foremost portion or nose, and at the flow channel surface. Once a layer has been deposited, the nose of the stream deposits layers of increasing thickness as it flows along. This would be expected because solidification obstructs the stream flow and increases the time that the nose of the stream is in contact with any unit of flow channel wall area. Finally the layer reaches a thickness equal to the radius of the flow channel, and all flow ceases. Let this be mechanism No. 1 or tip layer formation.

While the metal stream is flowing, it is also possible for the already formed layer at a distance behind the nose of the stream to grow in thickness. Possibly such a layer might grow more rapidly than the continually formed layer at the moving nose of the fluidity stream and thus bring the stream to rest by branching across the flow channel and totally obstructing metal flow. Let this be mechanism No. 2 or intra-stream growth.

A simple criterion determines which one of these two mechanisms brought the stream to rest. This is a presence of shrinkage cavities in or near the nose of the fluidity rod casting. With mechanism No. 2 prevailing, flow is completely obstructed some distance behind the nose. Solidification extending lengthwise from this point retracts some of the still liquid metal before it to compensate for its shrinkage.

Figure 10A is the cross section of the end of a fluidity rod cast in a 3/16-in. split bar flow channel. The shrinkage cavity, also found in the other zinc fluidity rods cast in split-bar flow channels, shows that mechanism No. 2 prevailed for these fluidity test runs. While mechanism No. 1 would be expected to reproduce fluidity lengths for identical casting conditions, mechanism No. 2, by its very nature, would introduce an element of variability in the results. The area where bridging occurs and the rate of such bridging depends upon the random orientation of the metal crystals in the first deposit.

Mechanism Control

In more familiar terms, dominance by mechanism No. 1 corresponds to a condition of directional solidification from the nose of the fluidity rod back. The variability of results will therefore be reduced by factors promoting directional solidification. These factors increase the temperature gradients established along the length of the fluidity rod. Lower flow velocity of the metal as well as greater heat conductivity, and lower heat content of the mold material, all contribute to directional solidification. The steepness of the temperature gradient along the length of cast rod also promotes dominance by mechanism No. 1.

Taking steps to produce a sound fluidity rod casting will thus also reduce the scatter found in fluidity results. This is illustrated in Fig. 10. Figure 10B is the cross section of the fluidity rod tip obtained with the use of a 3/16-in. I.D. copper tube for a flow channel. The greatly reduced shrinkage cavity at the tip shows that while mechanism No. 1 didn't fully dominate, flow was not cut off until the tip layer had almost filled the flow channel cross section. Figure 11, containing a plot of temperature vs fluidity length for the copper tube flow channel, shows a distinct improvement in reproducibility over the correlation obtained in Fig. 9. This improvement corresponds to the steeper temperature gradient obtained. The greater heat conductivity of copper chilled the reforming tip of the flowing stream, while the thin tube wall, quickly heated, reduced the heat absorption from the stream behind the tip.

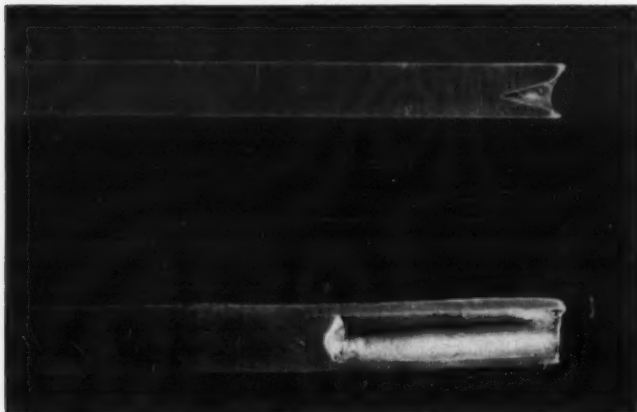


Fig. 10—Cross sections of zinc fluidity rod tips.
A-(top) Obtained in 3/16-in. split bar flow channel.
B-(bottom) Obtained in 3/16-in. I.D. copper tube flow channel.

From foundry experience we know that other factors influence temperature gradients. We would expect a larger diameter of flow channel to give a less favorable temperature gradient for the dominance of mechanism No. 1. With a 1/4-in. diameter channel, the shrinkage was indeed much more extensive than for 3/16-in. The drastic effect of freezing temperatures on favorable gradients was corroborated. Using a reservoir fluidimeter head with a 3/16-in. flow channel, tests were made with molten steel and lead. The lead fluidity rod exhibited a very extensive pipe while the cast steel rod appeared to be completely sound.

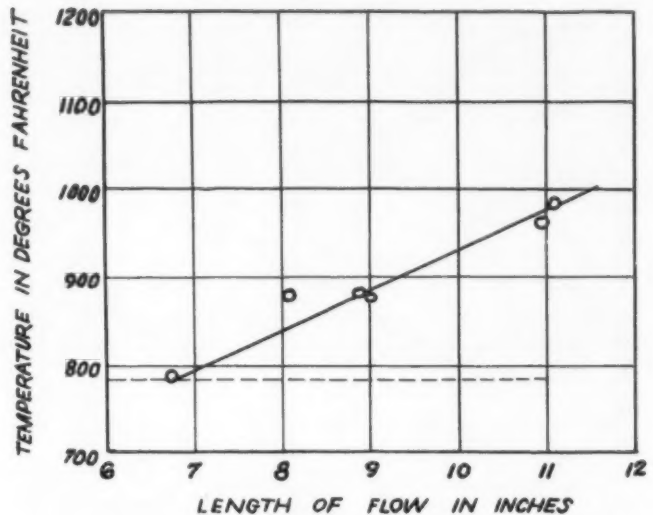


Fig. 11—The effect of temperature on the fluidity of molten zinc as determined by a reservoir fluidimeter with a 2-1/4-in. static head and a 3/16-in. I.D. copper tube flow channel.

While it would be expected that stream velocities would play a role in affecting the temperature gradients, a variation in the hydrostatic head from 1-1/2 to 3-1/2 in. did not produce a noticeable difference in the shrinkage cavities obtained.

CONCLUSIONS

- 1) The duration of the fluidity test is less than a second, making it impossible for a commercially gated mold to be independent of the human variable.
- 2) The use of a reservoir fluidimeter design permits fluidity rods to be cast under constant and reproducible metallostatic pressure.
- 3) The variation in fluidity length under identical metal and mold conditions was attributed to the dominance of one of two possible mechanisms of flow cessation.
- 4) There are two regions in the flow-time curve of the fluidity test for a pure metal, an initial constant velocity region probably corresponding to flow while the metal stream is completely liquid, and the final decelerating region during which solidification is occurring.

DISCUSSION

This investigation was intended to examine the design requirements for a successful plant fluidity tester. Although the performance of a fluidity tester was not studied under actual plant conditions, it would appear that the results are significant for such use.

The reservoir fluidity tester has been shown to deliver molten metal under a full static head (Fig. 8). It also gives fairly reproducible results (Fig. 11) even without the complete dominance of flow cessation by tip layer formation. This design was therefore recommended for plant use.

The use of firebrick is not recommended for the construction of fluidity tester heads. This material was used solely because of the lack of regular core making facilities. Green sand is also not recommended as it would magnify the heat loss while the reservoir head is being filled with molten metal. Subsequently, such heads were successfully produced from baked sand

as well as by the newer carbon dioxide process. Ceramic tube inserts were used here as in the firebrick construction.

One requirement of fluidity tester construction is that the flow channel be dimensionally reproducible. This can be accomplished by the use of both sand and metal molds. Use of pinned metal bars permits an accurately machined flow channel to be used over and over again. However, unless the flow channel is permitted to cool back to room temperature each time, the new uncontrolled variable of mold temperature will be introduced into the fluidity measurements. Thus it will be necessary to have a number of such metal bar flow channels available if frequent fluidity tests are to be made.

A second requirement of flow channel material is that it aid in the dominance of flow cessation by tip layer formation. For molten steel, both pinned metal bars and baked sand cores served as successful flow channel materials in this regard. For the lower melting non-ferrous metals, it is doubtful whether a sand flow channel will produce a steep enough temperature gradient along the fluidity rod length to insure flow cessation by tip layer formation.

The design requirements for a metal pinned bar flow channel are simple. Because of the quickness of the fluidity test as compared to the rate of heat conduction, wall thickness does not appear to be a variable, provided it is equal to or greater than the flow channel radius.

The use of thin walled tubing as an expendable flow channel for plant testing is possible but is probably less desirable because greater care is required in handling such an assembly. For some of the lower melting metals, however, it may be necessary to use tubing to obtain reproducible results.

ACKNOWLEDGMENTS

This study was made possible through the grant of a fellowship by the Acid Open Hearth Research Association. The advice and help of Prof. R. S. Mateer of the University of Pittsburgh were especially appreciated.

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APPENDIX

CALCULATION OF THE DIMENSIONS OF A PLANT RESERVOIR FLUIDIMETER

The fixed quantities which determine the design of the reservoir fluidimeter are W, the volume of molten metal that can be conveniently used for a single test and Q, the rate above which an operator can be safely expected to pour the molten metal into the fluidimeter. With these two quantities we can calculate the combinations of fluidimeter dimensions which will insure reproducible initial flow channel velocities.

This calculation will be illustrated for a cylindrical head well. Similar calculations for conical head wells are also available¹³. The critical dimensions affecting fluidimeter performance are the depth of the head well, H, the cross sectional area of the well, A, and the size of the orifice connecting the head well with the reservoir, "a". The other dimensions are related by these three. The reservoir volume is simply the difference between W and the head well volume, AH. The flow channel cross section should be kept to a value below "a" to insure fluidity flow under constant full head.

As molten metal is poured into the head well at a rate of Q cubic inches per second, some of it runs out of the orifice into the reservoir. This rate of efflux is governed by the instantaneous height, h, of metal in the head well.

$$\begin{aligned} \text{Rate of efflux} &= ca \sqrt{2gH} \\ \text{where } c &= \text{coefficient of discharge and is} \\ &\text{less than unity} \\ \text{and } g &= \text{gravitational constant} \end{aligned}$$

Since the rate of metal influx is equal to the rate of efflux plus the rate of accumulation of metal in the head, we have:

$$Q = ca \sqrt{2gh} + A \frac{dh}{dt} \quad (1)$$

Applying the boundary condition that h = 0 when the t = 0, we can determine t for h = H by integrating over the interval t = 0 to t = t

$$\int_0^t dt = \int_0^H \frac{A dh}{Q - ca \sqrt{2gh}} \quad (2)$$

$$t = \frac{-2AH}{ca \sqrt{2gH}} - \frac{2Q AH}{(ca \sqrt{2gH})^2 \ln \left(\frac{1 - ca \sqrt{2gH}}{Q} \right)} \quad (3)$$

Solving for AH, we obtain:

$$AH = \frac{-t(ca \sqrt{2gH})^2}{2[ca \sqrt{2gH} + Q \ln \left(\frac{1 - ca \sqrt{2gH}}{Q} \right)]} \quad (4)$$

Where t = time in seconds to fill the head well^o
 Q = rate of pour in in.³/sec.
 g = gravitational constant = 386.4 in./sec.²
 H = depth of head well in inches.
 A = cross sectional area of head well in in.²
 a = cross sectional area of orifice in in.²
 c = coefficient of discharge, dimensionless
 and AH = volume of the well in in.³

Introducing the volume of the pouring spoon, W , in.³, we note that $t = W/Q$. By substituting the symbol v for the expression $c\sqrt{2gH}$ we can reduce the expression for AH as follows:

$$AH = \frac{-Wv^2}{Q[v + Q\ln(1-v)]} \quad (5)$$

By definition, v = maximum rate efflux from the head well into the reservoir, i.e. when the head well is filled. Thus it is limited to values between 0 and Q , the rate of influx.

For a particular steel foundry, values of W equal to 8 in.³ and Q equal to 2 in.³/sec. were obtained. When these are substituted into equation (5) we obtain:

$$AH = \frac{-2v^2}{v + 2\ln(1-\frac{v}{2})} \quad (6)$$

For any assumed value of v , we can calculate the corresponding value of AH . The value of v is determined from conditions of head well depth and flow channel cross section which will insure flow cessation by tip layer formation. (The orifice cross section must be greater than that of the flow channel).

Because the kinematic viscosity of molten metals is somewhat less than that of water, we may safely use standard hydraulic values for the coefficient of discharge. Examples¹⁴ of values of " c " are 0.85 for 3/8-in. diameter orifices and 0.87 for 1/4-in. ones. Assuming a value of unity for " c " will simply give a greater factor of safety in the calculations.

The substitution of the chosen value of v into equation (6) yields a corresponding value of AH , which in turn yields A , the cross sectional area of the head well and $W-AH$, the necessary reservoir volume.

This paper has been approved for presentation at the 62nd Annual Meeting of the American Foundrymen's Society, to be held in Cleveland, Ohio, May 19-23, 1958. The Society reserves all rights for publication either prior to or subsequent to presentation, and is not responsible for statements or opinions advanced herein.

WRITTEN DISCUSSION IS SOLICITED

A STUDY OF THE FERRITIZATION OF NODULAR IRON

By

Earl J. Eckel*

ABSTRACT

Nodular irons of two compositions were subjected to four different types of ferritizing heat treatment: (1) slow cooling through eutectoid range, (2) quenching to and holding at temperatures both below and above the critical temperature for isothermal transformation, (3) reheating of pearlitic structures to various temperatures ranging from below to above the critical temperature, and (4) tempering of martensitic structures. The results of the treatments were compared on the basis of rate of response, tensile and impact properties of the treated specimens, and quantitative metallography.

INTRODUCTION

The attainment of maximum ductility in nodular iron usually requires the application of some heat treatment to promote decomposition of carbides present in the as-cast state. A survey of the literature reveals the existence of numerous recommendations and practices for carrying out the necessary heat treatment. This investigation was initiated to make a study of the various possible methods of annealing in order to evaluate them with regard to efficiency and practicability; and also with respect to the properties of the resulting products.

The responsiveness of nodular iron largely centers around the metastability of cementite. Cementite at elevated temperatures will decompose to graphite and ferrite and/or austenite depending on the composition and temperature of the iron. The greater solubility of the metastable phase as compared to the stable phase in the matrix, which in this particular case is either ferrite or austenite or both, results in a composition gradient in the matrix and thus makes the necessary diffusion possible.

The various heat treatments that will produce a microstructure consisting of graphite in a matrix of ferrite may be classified into the four types that are diagrammatically illustrated in Fig. 1. All treatments shown involve as a first step, austenitizing at a rela-

tively high temperature to attain austenite and graphite. As the decomposition rate of cementite is greatly increased by an increase in temperature, the holding time should be sufficient to eliminate any residual cementite that may exist after the austenitizing temperature is reached. The time and temperature will therefore be dependent on both the composition and cooling rate of the casting in the mold. In cases where free cementite is absent or occurs in small amounts, it may be considered uneconomical to include the high temperature treatment.

Type A treatment involves cooling at a sufficiently slow rate so that the decrease in the solubility of carbon in the metal matrix with a decrease in tem-

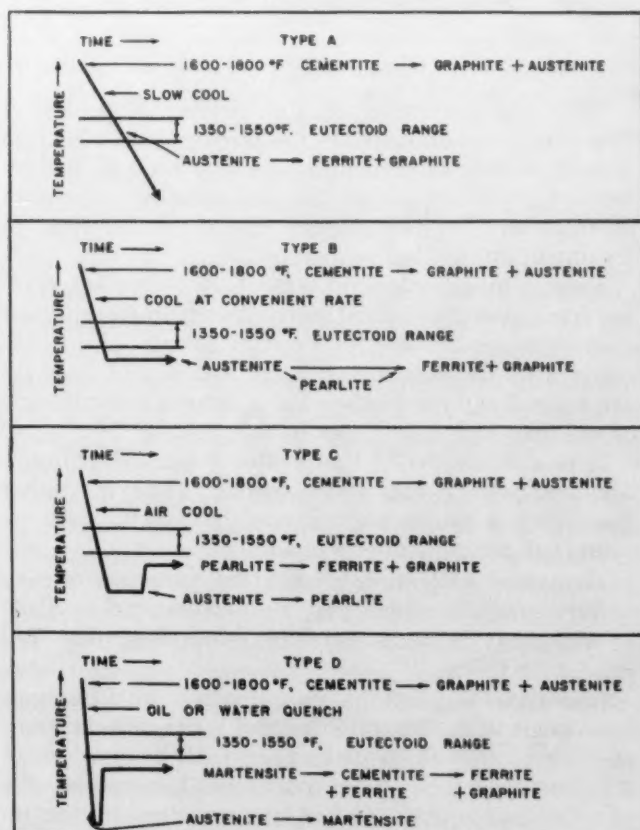


Fig. 1 - Various types of ferritizing treatments.

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This paper represents part of a thesis submitted by Earl J. Eckel to the Graduate College of the University of Illinois in partial fulfillment of the requirements for the degree of Doctor of Philosophy.

perature will result in the formation of additional graphite rather than cementite.

Type B treatment consists of cooling at any convenient rate from the austenitization temperature to a temperature below the critical range and then allowing sufficient time for conversion of the austenite to ferrite and graphite. It would be expected that some of the austenite would decompose directly to ferrite and graphite while another part would form pearlite first which would subsequently decompose.

Type C treatment differs from Type B in that the metal is cooled from the austenitizing temperature to a temperature, or over a temperature range, so as to transform the austenite to pearlite (or to pearlite plus ferrite and graphite) and then is reheated to a higher temperature for decomposition of the cementite in the pearlite. Thus, in this treatment, transformation of austenite and ferritization are carried out at different temperatures rather than at a single temperature as in Type B treatment.

Type D treatment, while representing a way of achieving a ferrite-graphite microstructure, has not, insofar as the author knows, been recommended for producing a high ductility nodular iron. It was felt however that for completeness this treatment should be included. As indicated, a quench from the austenitization temperature develops a martensitic matrix which is then decomposed at a temperature below the eutectoid range to form ferrite and graphite. Data have already been reported¹ to show that martensite during decomposition not only gives a fine dispersion of carbides but also may produce additional graphite particles, in contrast to Type A, B, and C treatments in which graphitization involves a growth of the nodules present prior to the heat treatment.

Comparing Heat Treatments

With the exception of the obvious requirement that for maximum ductility the ferritized nodular iron should be free of cementite, there is little in the literature regarding either the comparative economics of treatments or the relative effects of the type of treatment on the final properties.

Several investigators^{2,3,4} state that controlled cooling from over the critical range results in the shortest overall annealing time for a ferritic matrix. This method is also the simplest if large batches of castings are treated and the furnace has a natural cooling cycle of less than 35 F (19 C) per hour.⁵

It is also claimed^{6,7} that better impact ductility is obtained with a two stage anneal (Type B) rather than with a single stage process (Type C with no prior high temperature treatment).

There are indications^{1,8} that the presence of secondary graphite which may be encountered in Type D treatment is detrimental to both elongation and impact ductility.

Inasmuch as most of the reported investigations have dealt with either one or two types of heat treatment, it is difficult to make an overall comparison of the four types of heat treatment because of the effect of composition and as-cast structure on the response to heat treatment. In line with this viewpoint this investigation was undertaken to study the re-

sponse of two different nodular irons to the various types of heat treatment.

MATERIALS

The two nodular irons used in the investigation were obtained from different sources—one as a gift from the International Harvester Company and the other purchased from Jamestown Malleable Iron Company. Both irons were received as 1-in. Y-blocks and had the chemical compositions listed in Table 1.

The letters "B" and "E" as indicated in Table 1 will be used throughout the paper to designate the two irons.

TABLE 1 — CHEMICAL COMPOSITION OF NODULAR IRONS USED IN THE INVESTIGATION

"B" Iron (From Jamestown Malleable Corp.)			
T.C.,%	3.62	Ni,%	1.65
Si,%	2.42–2.59	Cu,%	0.15
S,%	0.015	Cr,%	0.05
P,%	0.06	Mg,%	0.07–0.075
Mn,%	0.4		
"E" Iron (From International Harvester Co.)			
T.C.,%	3.65	Ni,%	0.17
Si,%	2.83	Cu,%	0.22
S,%	0.010	Cr,%	0.10
P,%	0.045	Mo,%	0.04
Mn,%	0.30	Mg,%	0.054

The difference in the nickel content of the two irons is a result of the addition agents employed for adding the necessary magnesium. A nickel-magnesium alloy was used for the "B" iron while the addition was made to "E" iron in the form of an iron-silicon-magnesium alloy. As might be expected, the higher silicon and lower nickel content of the "E" iron gives this material more rapid response to the ferritization heat treatments.

In order to minimize the effect of the as-cast structure on the test results, the tensile and impact speci-

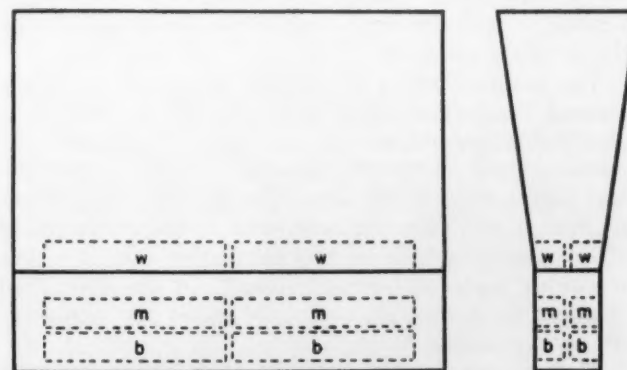
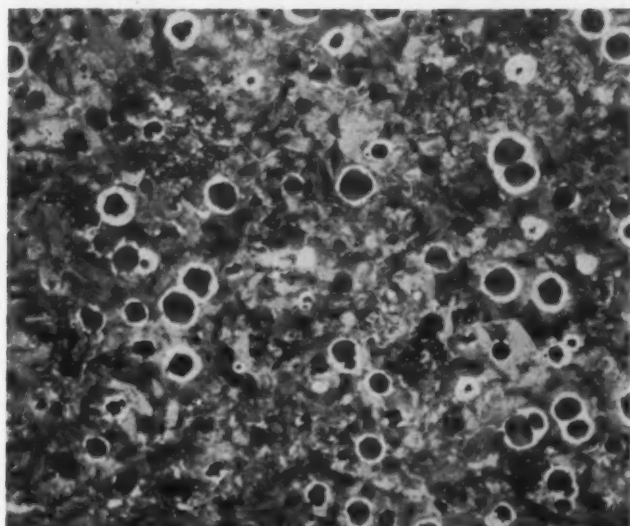


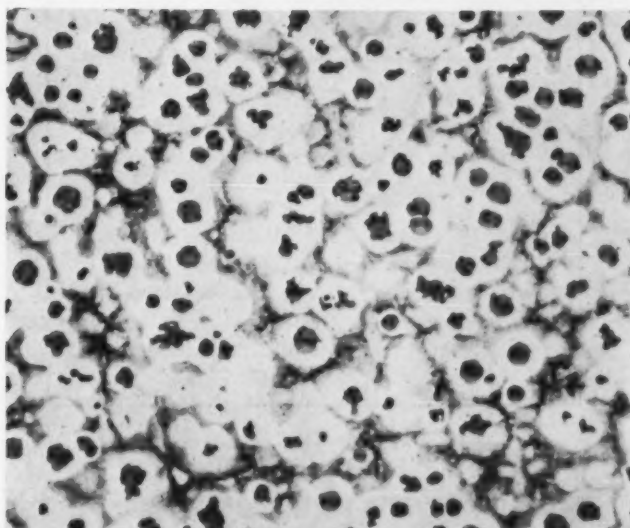
Fig. 2 — Location of specimens in Y-block

mens were taken from the locations "m" and "b" shown in Fig. 2. Specimens for determination of reaction rates that were needed for obtaining isothermal transformation diagrams were cut from the "w" location to conserve metal.

Typical microstructures of both "B" and "E" metal at the "m" location are given in Fig. 3. The greater tendency of "E" metal to ferritize is well illustrated by these structures. Average mechanical properties for



a. "B" metal



b. "E" metal

Fig. 3 — Typical microstructure of inside end of "m" blanks (See Fig. 2) of as-received metal. Light areas are ferrite surrounding nodules of graphite and gray matrix is pearlite.

TABLE 2 — PROPERTIES OF AS-RECEIVED IRONS

	Tensile Strength, psi	Yield Strength, psi	Elongation, %	Reduction of Area, %	Impact, ft-lb
"B" Iron	108,500	76,300	4.0	2.5	3
"E" Iron	89,700	57,500	9.3	8.3	40

the nodular irons in the as-received condition are listed in Table 2.

SPECIAL EQUIPMENT AND TECHNIQUES

The necessity for the conservation of metal led to the adoption of small tensile and impact specimens. The tensile specimens were round, threaded, and had a three-quarter inch gauge length. The dimensions of the specimens were those suggested in the *American Society for Metals Handbook*. The yield strength was determined by the offset method using a 0.2 per cent offset.

Impact tests were made on unnotched Charpy specimens that had a cross section of 0.3125 sq in. and

a length of 2.165 in. A pendulum energy of 110 ft-lb was used.

The desirability of relating the heat treatments to the mechanical properties and microstructure introduced the problem of determining the percentages of the constituents present in a specimen. This was done by means of lineal analysis using the well-known Hurlbut counter.⁹

PRELIMINARY PROCEDURES

In the as-cast condition "B" iron contained a small amount of free cementite while "E" iron showed a relatively large per cent of ferrite. It appeared desirable to eliminate both of these by a preliminary treatment so that as complete a picture as possible could be obtained of the ferritization process by subsequent treatments. A number of heat treatment tests revealed that if the 7/16-in. square blanks used for making the test specimens were heated to 1800 F (980 C) for 2-1/2 hr and then cooled in air, the free cementite was removed and the free ferrite was reduced to a small value—0.4 per cent in "B" iron and 5.8 per cent in "E" iron.

Because the rate of ferritization below the critical range would increase with an increase in temperature it was important to know the maximum temperature that could be used without encountering austenite formation. This temperature is frequently called the critical temperature.

Preliminary tests on nodular irons had revealed the sluggishness with which austenite forms at temperatures near the critical temperature. Therefore a series of specimens were heated for 14 hr at various temperatures, the range of which would bridge the critical temperature, and then quenched in water. It was then a simple matter to determine from the microstructure the location of the critical temperature—found to fall between 1350 and 1360 F (732 and 738 C) for "B" iron and between 1380 and 1390 F (749 and 754 C) for "E" iron.

TENSILE PROPERTIES VERSUS TYPE OF HEAT TREATMENT

One of the objects of the investigation was to determine what effect, if any, the type of ferritizing treatment had on the mechanical properties. In this respect it was desirable not only to evaluate fully ferritized iron, but also to assess the effect of residual carbides. The detrimental effect of the latter might be materially influenced by variations in their shape and distribution.

It was therefore planned to analyze the following four types of treatments. (1) Cool at various rates from 1800 F (980 C). (2) Quench from 1800 F (980 C) into a lead bath maintained at various temperatures in the range of 1100 to 1425 F (595 to 775 C) and hold for ferritization. An experimental study of this treatment is somewhat more involved than treatments (1) and (4), and will be discussed in the section entitled Isothermal Transformation of Cooled Specimens. (3) Air cool from 1800 F (980 C) to room temperature followed by reheating for ferritization.

This treatment is dealt with in two sections; one in which ferritizing was at 1340 F (725 C) to study in particular the effect of time at a typical commer-

cial heat treatment temperature; and a second in which the effect of time at decomposition temperatures over a range of 1320 to 1425 F (775 to 800 C) was investigated. The latter work is discussed under the heading Isothermal Transformation of Reheated Specimens. (4) Quench to martensite from various austenitizing temperatures and ferritize at 1340 F (725 C).

The four different treatments therefore approach the fully ferritic matrix by four different mechanisms and should reveal whether or not it makes any difference as to how the ferritic structure is obtained. Conclusions drawn from this study should be applicable at least qualitatively to other heat treatments that involve more than one of the four mechanisms.

Ferrite Formation Versus Cooling Rates

Tensile specimen blanks, 7/16 x 7/16 x 3 in. were cut from "B" and "E" iron Y-blocks; heated at 1800 F (980 C) for 2-1/2 hr; and then cooled at various rates. The cooling rate was measured by inserting a thermocouple in the center of one of the specimens and connecting it to an automatic recorder. Cooling rates, considering the time interval from 1450 F to 1200 F (790 C to 650 C), ranged from 20,880 F (11,600 C) per hour for the specimens cooled individually in air to 110 F (60 C) per hr for specimens cooled in the furnace. The 1450 to 1200 F (790 to 650 C) range was used because Millis⁵ in his recommendations for ferritizing nodular iron states that with Type A heat treatment (slow cool through eutectoid range) the cooling rate should not exceed 35 F (20 C) per hr in this temperature range. The interval of 1450 to 1200 F (790 to 650 C) would be expected to cover the most active range of graphitization.

The natural cooling rate of the furnace was much faster than the maximum recommended, being 110 F (60 C) per hr. Because full ferritization was obtained in "E" iron and close to 100 per cent ferritic matrix (95.4 per cent) in "B" iron, no attempt was made to attain a slower cooling rate.

Cooling rates between those mentioned above were obtained by inserting the specimens in various sizes of low carbon steel cylinders; then subjecting the cylinders to austenitization at 1800 F (980 C); removing them from the furnace; and cooling in air or in the furnace with the cover removed. In all cases a dummy specimen containing a thermocouple was run with the other two specimens (one each from "B" and "E" iron) to insure the holding time of 2-1/2 hr at 1800 F (980 C) as well as to measure the cooling rate.

During some preliminary surveys in which variations in specimen design and methods of measuring elongation were studied, duplicate specimens were used in the tests. The excellent agreement between duplicate specimens made it appear that it was a waste of both time and material to continue this practice in cases where a continuous curve was expected from a series of specimens. Should scatter or irregularities develop, additional specimens could be tested for a check.

After heat treatment the tensile specimens were machined and tested. Measurements were made of

ultimate strength, yield strength, per cent elongation, and per cent reduction of area. One of the halves of each of the fractured specimens was cut at the 9/32-in. shoulder and subjected to a lineal analysis to determine the per cent of dispersed carbide areas in the matrix. By basing the percentage on the matrix only, the values give a more direct measure of the degree of ferritization.

Figure 4 shows a plot of cooling rates versus per cent of ferrite in the matrix for both "B" and "E" irons, and illustrates the greater tendency of "E" iron as compared to "B" iron to form ferrite. The term ferrite in this paper refers to free ferrite, and therefore does not include the ferrite present in admixtures

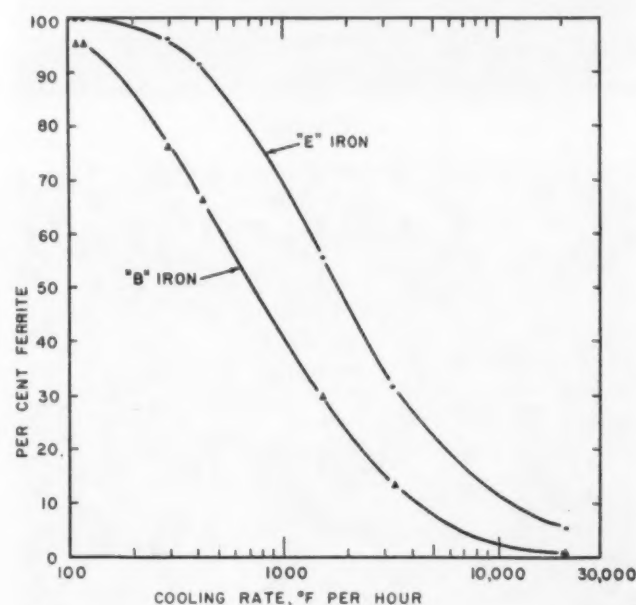


Fig. 4 — Per cent ferrite versus cooling rate from 1800 F (980 C).

of carbides and ferrite. For the range of cooling rates used, the fastest rate was not great enough to surpass all the ferrite in either iron (5.8 per cent present in "E" iron and 0.04 per cent in "B" iron), while the slowest cooling rate was too rapid to prevent the formation of some dispersed carbide areas (4.6 per cent present) in "B" iron.

Tensile properties for "E" iron versus per cent of ferrite are plotted in Fig. 5. The results for "B" iron are not included because of the similarity to "E" iron. The properties in general show a relatively high sensitivity to the per cent of ferrite throughout the range studied. It may also be noted that the rate of drop of the yield strength and tensile strength decreases as the per cent of ferrite increases. The rate of the change of per cent elongation, on the other hand, is practically constant. The somewhat greater scatter of the points for the per cent reduction of the area is not unexpected, considering the small diameter of the specimens and the difficulty of locating and measuring the minimum diameter.

The curves illustrate the remarkable range of properties obtainable through a variation in the amount of pearlite in the matrix. Even with a tensile strength of 14,000 psi the irons have 2 per cent elongation.

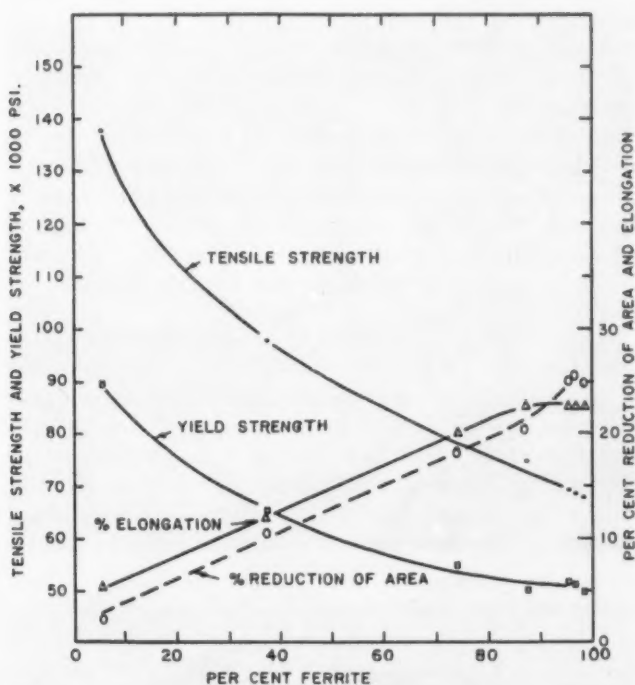


Fig. 5 — Mechanical properties of "E" iron versus per cent ferrite for Type A heat treatment (cooled at various rates from 1800 F (980 C)).

With very little pearlite present the strength is near 70,000 psi and the elongation is over 20 per cent.

It was noted that pearlite with the lowest cooling rates used was clearly lamellar. This will be an important consideration when comparisons are made with other heat treatments in which the residual carbides are spheroidized.

Ferritization of Pearlite at 1340 F (725 C)

A series of 7/16 x 7/16 x 3-in. blanks for tensile specimens were packed in charcoal, heated for 2-1/2 hr in a furnace at 1800 F (980 C) and then cooled individually in air. As mentioned previously this gave

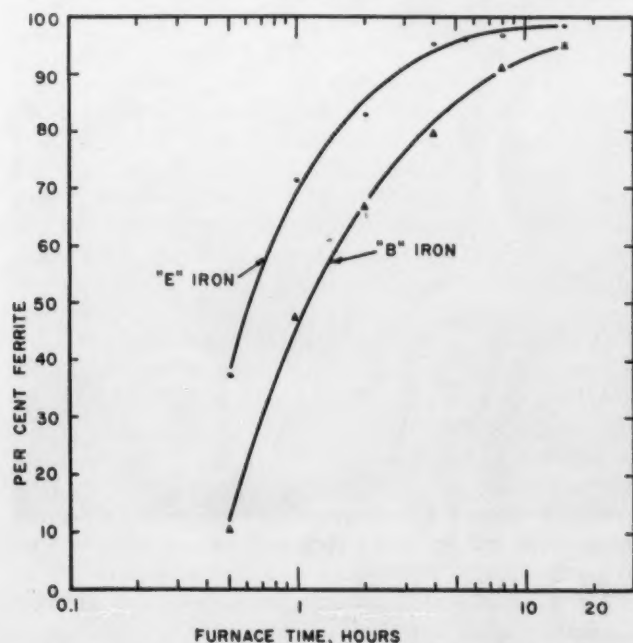


Fig. 6 — Per cent ferrite versus time in 1340 F (725 C) furnace.

matrices that were practically all pearlite. The per cent of ferrite was 0.4 per cent for "B" iron and 5.8 per cent for "E" iron. A series of heat treatments was then conducted to determine the effect of heating at 1340 F (725 C). The times used were 1/2, 1, 2, 4, 8, and 16 hr. The heating was done in a muffle type furnace. Tensile specimens were machined from the blanks, tested, and subjected to lineal analyses.

Plots of per cent ferrite in the irons versus time in a 1340 F (725 C) furnace are given in Fig. 6. The reduction in the rate of ferritization with time is to be expected because of the increasing length of the diffusion path from the cementite to the graphite. The cementite adjacent to the graphite decomposes first. So with increasing time there is an ever widening band of ferrite between the graphite and the dispersed carbide areas, and therefore a decreasing concentration gradient of carbon in the ferrite.

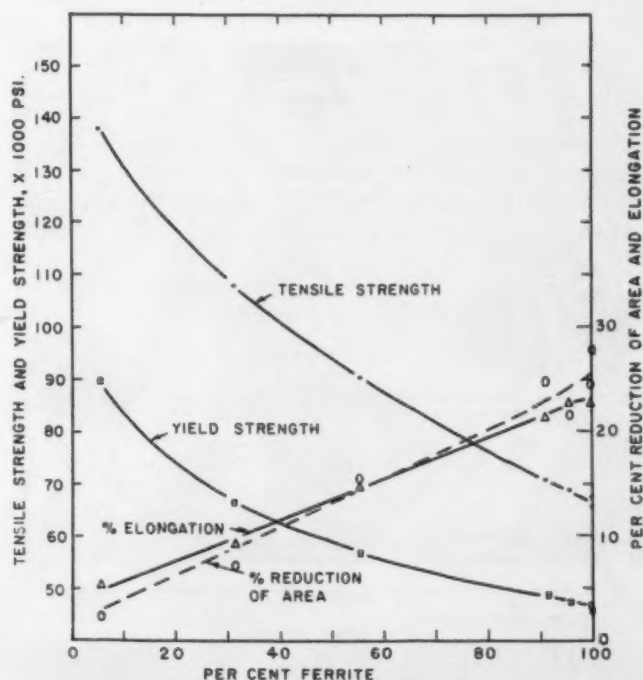


Fig. 7 — Mechanical properties of "E" iron versus per cent ferrite for Type C heat treatment (pearlitic matrix decomposed at 1340 F (725 C)).

Figure 7 gives the relationship between the mechanical properties and the per cent of ferrite in the matrix for "E" iron and is also representative of the results obtained with "B" iron. The elongation and reduction of area undergo virtually a constant rate of change until a value of about 90 per cent ferrite is reached. In contrast the tensile strength and yield strength exhibit a decreasing rate of change as ferritization progresses. It is also evident that the yield strength is not appreciably affected by increasing the per cent of ferrite from 80 to 100 per cent.

The maximum elongations for "B" and "E" irons, namely 20 and 22.6 per cent, were obtained in 8 hr for "B" and 2 hr for "E" iron, and accompanied a matrix having about 90 per cent ferrite. Additional ferritization did not appear to be beneficial to the per cent elongation. The residual dispersed carbide areas with this treatment were spheroidized. Therefore,

as might be expected, they had less effect on the properties than the lamellar type areas present in the slowly cooled specimens obtained with the A type treatment discussed in the previous section.

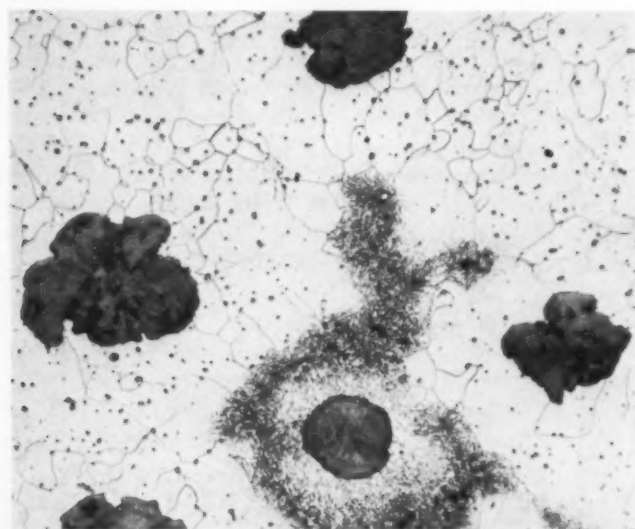
Ferritization of Martensite

A number of investigators have mentioned that the ferritization of martensite may lead to formation of additional graphite nodules which they have called secondary graphite. Also the austenitizing temperature which determines in part the amount of carbon dissolved in martensite has been recognized as an important factor in this phenomenon.

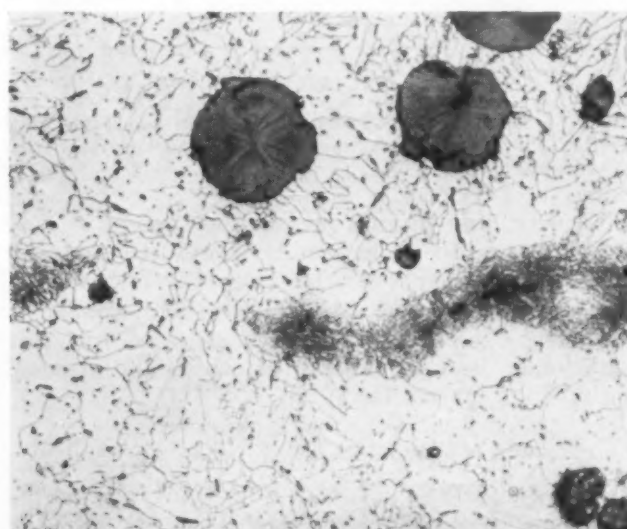
A preliminary survey of the effect of the austenitizing temperature on the as-quenched structure as well as on the ferritized structures was made by quenching a series of 1/8-in. thick specimens from temperatures ranging from 1000 to 1900 F (540 to 1040 C) and then ferritizing for 1 hr at 1340 F (725 C). The higher

austenitizing temperature resulted in a greater percentage of retained austenite and coarser martensite plates in the as-quenched condition. The ferritized structure also showed a marked effect of the austenitizing temperature, as illustrated in Fig. 8. It is apparent that with an increase in the austenitizing temperature there is an increase in the amount of secondary graphite. With the higher temperatures, the shape of the graphite is plate-like rather than spherical, and there is a greater tendency for the graphite to be located at the ferrite grain boundaries.

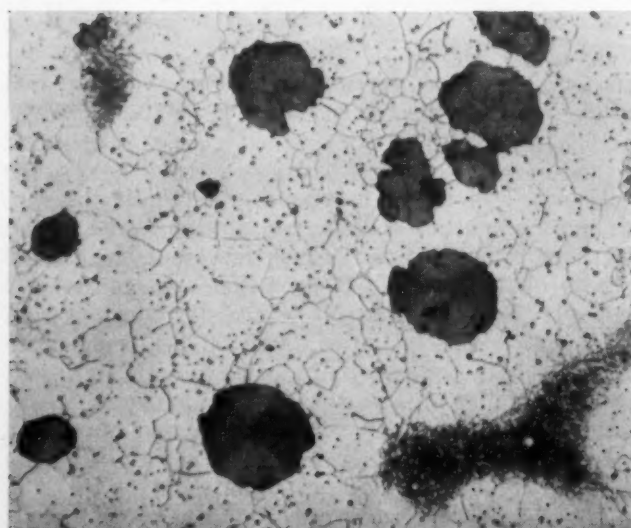
The elongated graphite is accompanied by elongated grains of ferrite rather than the equiaxed shapes found for lower temperatures. It is known that the plates of martensite become plates of ferrite during tempering. The lack of the plate-like shape for lower temperatures can be attributed to their initially smaller size which would increase the relative surface energy and promote growth with a tendency to change



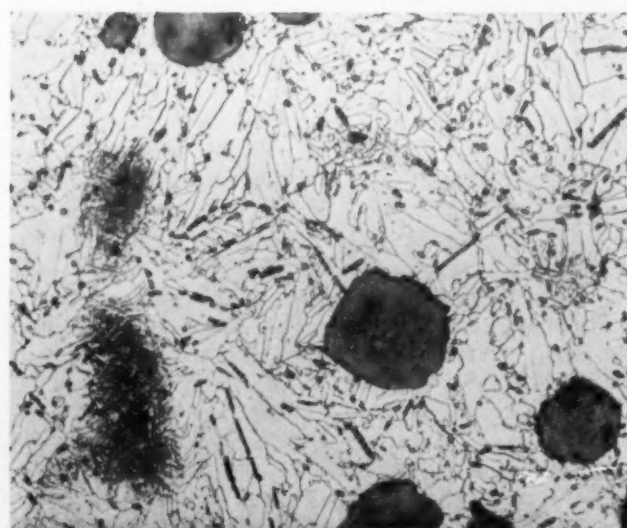
a. 1500 F



c. 1800 F



b. 1600 F



d. 1900 F

Fig. 8 — "B" metal normalized (2-1/2 hr at 1800 F), reheated for 2 hr at indicated temperature and oil quenched, and then reheated for 1 hr at 1340 F. $\times 200$.

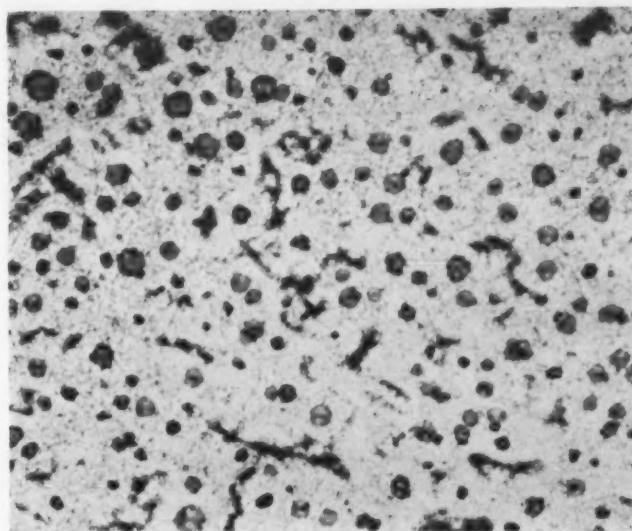
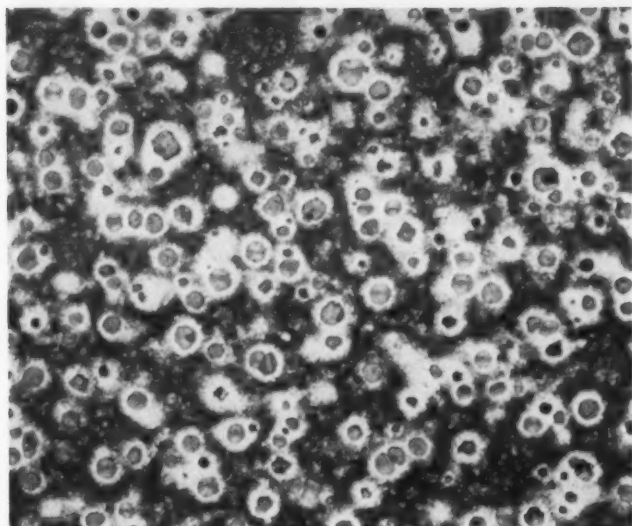


Fig. 9 — Comparison of martensitic and pearlitic matrices on response to ferritization treatment of 1 hr at 1340 F. Left — Air-cooled (pearlitic). Right — Oil quenched (martensitic) from 1800 F, both "B" metal.

to an equiaxed shape. It is also possible that the relatively large amount of secondary graphite formed at the boundaries in the high temperature specimens materially inhibits grain boundary migration.

The low mechanical properties that were encountered when high austenitizing temperatures were used is easily understood from a study of the 1900 F (1040 C) specimens. The elongated graphite would be very effective in reducing the continuity of the metal and lowering both its strength and ductility. On the other hand, the introduction of the secondary graphite would reduce the diffusion paths for carbon and consequently should increase the rate of ferritization. This is clearly revealed by Fig. 9, which illustrates the effect of a one hr ferritization at 1340 F (725 C) on normalized specimens and specimens quenched from 1800 F (980 C).

The effect of secondary graphite on the properties of ferritized specimens was studied by using austenitizing temperatures of 1500, 1600, and 1800 F (815, 870, and 980 C). The tensile specimen blanks that were austenitized at 1500 F (815 C) and 1600 F (870 C) were first normalized from 1800 F (980 C), but the 1800 F (980 C) specimens were not given a prior treatment. After 2 hr at the given temperature the specimens were quenched in oil. To reduce the danger of cracking during the ferritizing treatment the specimens were tempered 1 hr at each of the temperatures 300, 650, and 1000 F (150, 345, and 540 C). A check showed that no ferritization resulted from this treatment. Ferritization was carried out at 1340 F (725 C) for 1/2, 1, 2, 4, and 8 hr.

The results are plotted in Fig. 10. Yield strengths were not determined for these specimens because it was found in a preliminary survey that specimens with secondary graphite had a great tendency to break in the gage marks that were needed for attachment of the extensometer. The elongation was obtained by coating the specimens with lacquer which served as a medium for retention of the gage length marks.

Both the 1600 and 1800 F (870 and 980 C) austenitizing temperatures gave low elongations compared

to the maximums of 20 per cent or more obtained by ferritizing pearlite (discussed in previous section). The tensile strengths are however about the same as those for the ferritized pearlitic specimens that had close to a 100 per cent ferritic matrix. The low strengths after only 1/2 hr at 1340 F (725 C) are largely due to the high rate of ferritization, as was discussed above and is illustrated in Fig. 9.

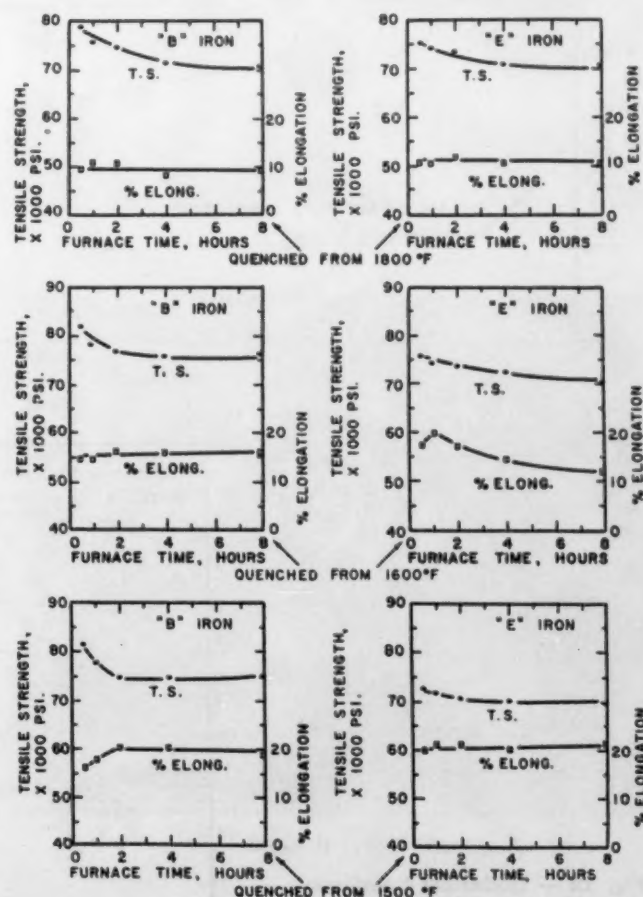


Fig. 10 — Effect of quenching temperature on properties obtained with tempering for various times at 1340 F (725 C).

The 1500 F (815 C) austenitizing treatment gives about the same magnitude of elongation (20 per cent) as obtained with ferritization of pearlite; but this value is reached in a shorter time. The low strength of "E" iron as compared with "B" iron after a 1/2 hr ferritization treatment is to be anticipated because an appreciable amount of ferrite was present in "E" iron prior to quenching.

No lineal analyses were made of these specimens due to the added difficulty caused by the presence of the secondary graphite.

ISOTHERMAL TRANSFORMATION

Isothermal Transformation for Cooled Specimens

One of the aspects of the heat treatments of nodular irons that has received surprisingly little attention is the isothermal transformation characteristics. The only work of this nature that the author located in the literature during the investigation was a partial IT (isothermal-transformation) diagram reported by Rowady, Murphy, and Libsch,¹⁰ but later it was called to the author's attention that Brown and Hawkes¹¹ had published a paper on this subject. From the standpoint of ferritization an important feature of an IT

diagram would be the rate of direct formation of ferrite from austenite. Such a transformation might occur at temperatures in and below the eutectoid range of the equilibrium phase diagram. It appeared desirable therefore to determine IT diagrams for "B" and "E" irons.

Specimens, 1/8-in. slices of 7/16 x 7/16 x 3-in. blanks that had been heated for 2-1/2 hr at 1800 F (980 C), were transferred to lead pots maintained at a given temperature and then quenched after a predetermined length of time. The temperature range studied was 1100 to 1425 F (595 to 775 C) and the times were 1-1/2 to 480 min. An examination of the microstructure gave the times for the beginning and ending of the various reactions and they are plotted in Figs. 11 and 12.

The IT curves clearly show the greater sluggishness of "B" iron as compared to "E" iron. Photomicrographs were taken to illustrate the different types of microstructures. Considering the "B" iron IT curve (Fig. 11), the first change occurring at 1425 F (775 C) involves the formation of pearlite which is illustrated in Fig. 13a. After a time of about 45 min the pearlite begins to decompose, and this decomposition is complete in about 200 min, as represented in Fig. 13b. For

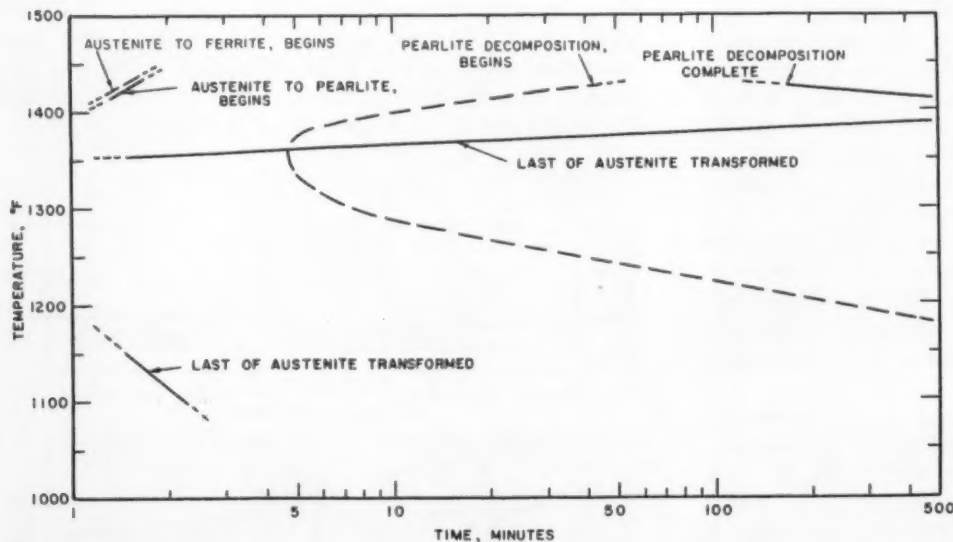


Fig. 11 - Isothermal transformation of cooled "B" iron.

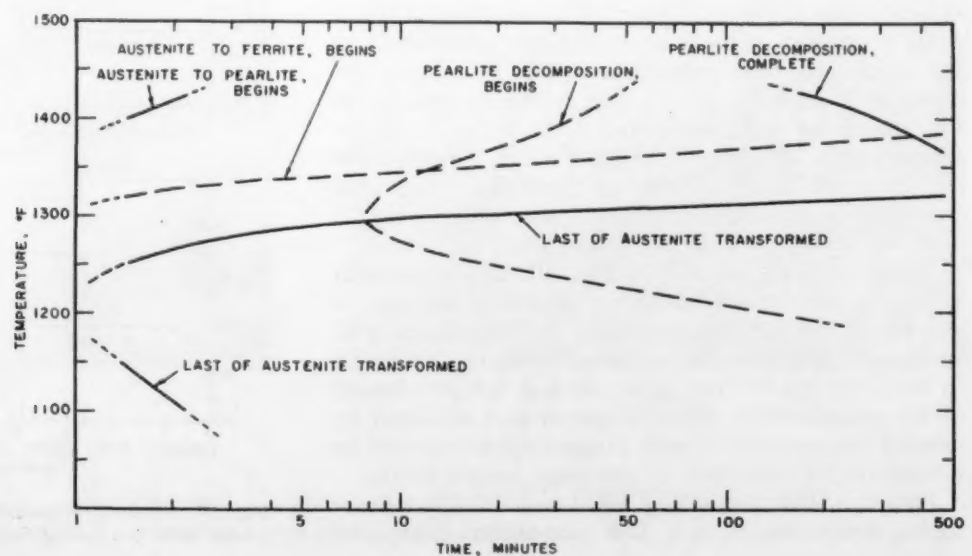
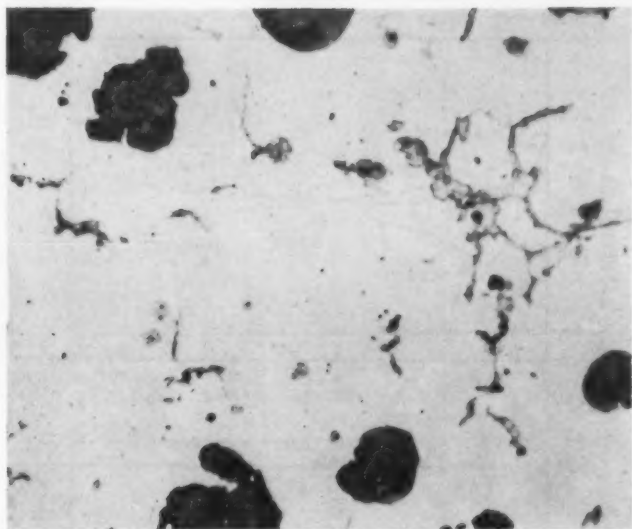
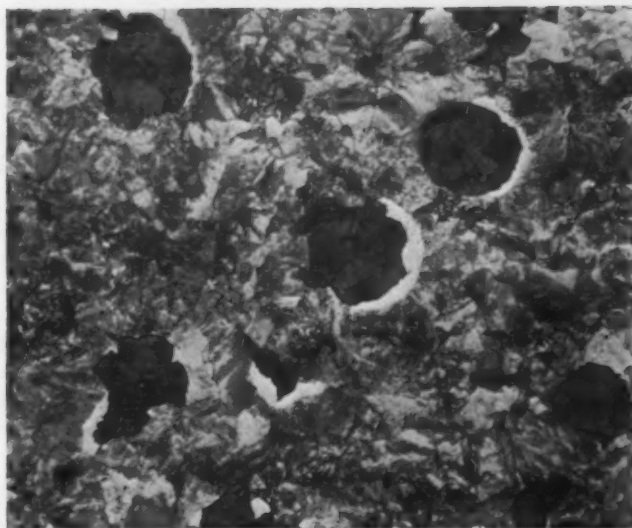


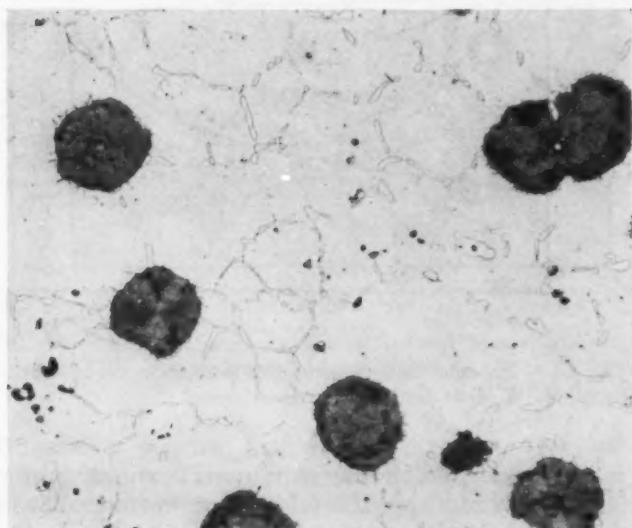
Fig. 12 - Isothermal transformation of cooled "E" iron.



a. 30 min at 1425 F (775 C).



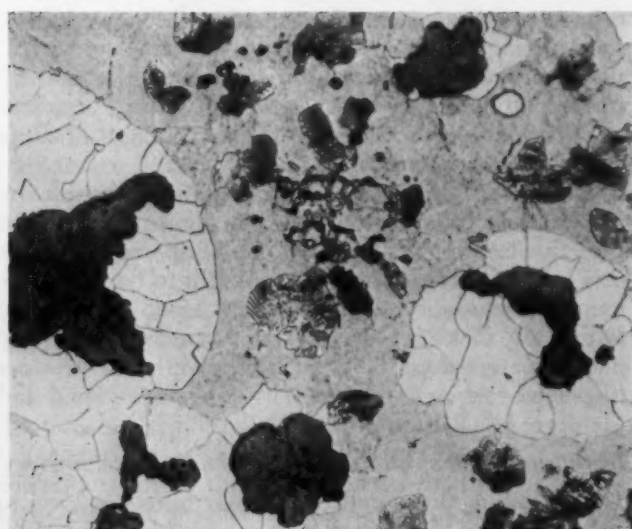
d. 1-1/2 min at 1200 F (650 C).



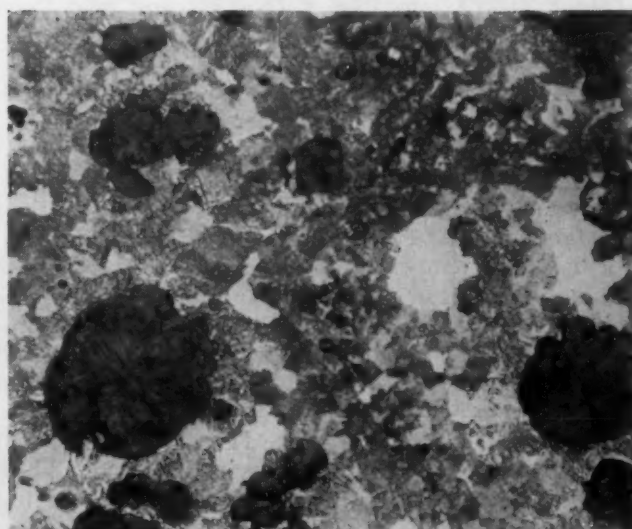
b. 200 min at 1425 F (775 C).



e. 1 hr at 1200 F (650 C).



c. 5 min at 1300 F (700 C).



f. 1-1/2 min at 1100 F (590 C).

Fig. 13 — Typical microstructures obtained in isothermal transformation treatments. Specimens quenched into lead from 1800 F (980 C). For clarification, microstructures are referred to IT curve for "B" iron, Fig. 11.

this decomposition to occur it can be seen that the austenite must transmit the carbon from the carbide of the pearlite to the graphite nodules.

At a lower temperature, in "B" iron at 1300 F (700 C) for instance, some pearlite forms first in regions about midway between the graphite nodules as shown in Fig. 13c, and is then followed by the direct transformation of austenite to graphite and ferrite, the latter phase surrounding the graphite.

At still lower temperatures, where the rate of transformation of austenite is more rapid, less or no ferrite forms. A specimen with but a small amount of ferrite is shown in Fig. 13d. As has been discussed previously, with sufficiently long holding time pearlite will spheroidize and decompose, giving a structure similar to that of Fig. 13e.

Below the temperature of 1200 F (650 C) the decomposition rate of austenite decreases and there is no direct formation of ferrite from austenite. Hence specimens in which the transformation of austenite is incomplete will be composed of austenite (martensite after quench) and pearlite as shown in Fig. 13f.

A comparison of the IT curves for "B" and "E" irons not only indicates the more rapid transformation of the latter, but also shows the transformations for "E" iron are spread over a considerably wider temperature range. It may be noted, too, that the austenite to ferrite transformation in "E" iron starts at about the same time as for the austenite to pearlite transformation, instead of at a much later time.

The IT diagram published by Brown and Hawkes,¹¹ although it was for an iron similar to "B" iron in chemical composition, had markedly different reaction rates for the higher temperatures. Above 1255 F (680 C) it showed the austenite to graphite plus ferrite reaction to precede that for austenite to pearlite, the reverse of what was obtained with "B" iron. The major differences in experimental procedures concerned the austenitizing treatments. In this investigation the quench was from 1800 F (980 C) while Brown and Hawkes slowly cooled their specimens from 1742 F (965 C) to 1562 F (830 C) and held them 1 hr before quenching. It follows that the austenites of the two different treatments differ prior to quenching in regard to carbon content and possibly with respect to the distribution of other elements.

It is important to note also that, at the higher transformation temperatures, Brown and Hawkes' specimens gave a general precipitation of ferrite rather than the familiar bull's-eye pattern which was characteristic for the lower temperatures in their specimens, and for all temperatures in the author's specimens. The author encountered the same general type of ferrite precipitation when low austenitizing temperatures were used and he attributed this to a lack of homogenization in the austenite.

An examination of the above IT curves for "B" and "E" irons discloses the various mechanisms taking place and the times required for the beginning and ending of certain changes, but it fails to reveal the amount of ferrite present at a given time and temperature. To obtain this information lineal analyses were made for specimens held 1 hr and 8 hr at the various temperatures. The results are plotted in Figs. 14 and 15. These equi-time curves emphasize the difference in

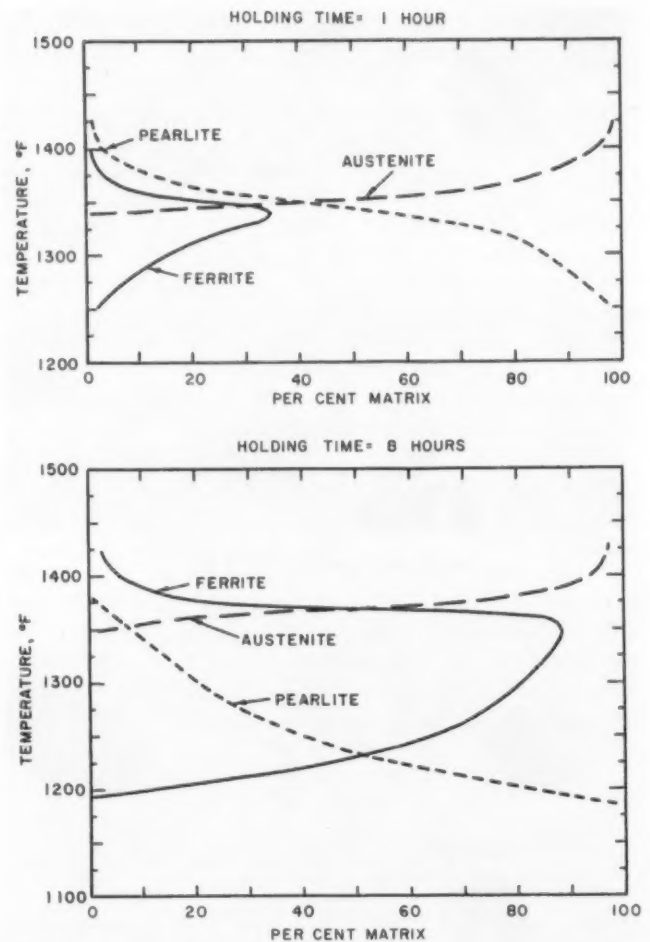


Fig. 14 — Per cent microconstituents present in cooled specimens of "B" iron isothermally transformed.

ferritization rates of the two irons. Not only is the "B" iron more sluggish insofar as ferrite formation is concerned, but the region for a high rate of ferrite formation is confined to a very narrow temperature range. The difference between the two irons with an 8 hr treatment is much less than for 1 hr because of the slowing of the transformation as the amount of ferrite around the graphite and consequently the diffusion path increases.

These curves also indicate the percentages of other constituents that make up the part of the matrix that is not ferritized. This is of some value in estimating the effect of the microstructure on the tensile properties. For example, the presence of dispersed carbides at a relatively high temperature ought to be less detrimental to ductility than austenite. Upon cooling the latter, say in air, it would transform to a relatively fine and therefore hard pearlite, while the former dispersed carbides would tend to be spheroidized and therefore less hard and brittle.

Isothermal Transformations for Reheated Specimens

As mentioned previously, nodular irons are slow to form austenite during reheating, and this characteristic gives some difficulty when the critical temperatures are determined. It appeared that this sluggishness for austenite formation, in view of the great accelerating effect of an increase in temperature on ferritization of pearlite, might be turned to an advantage.

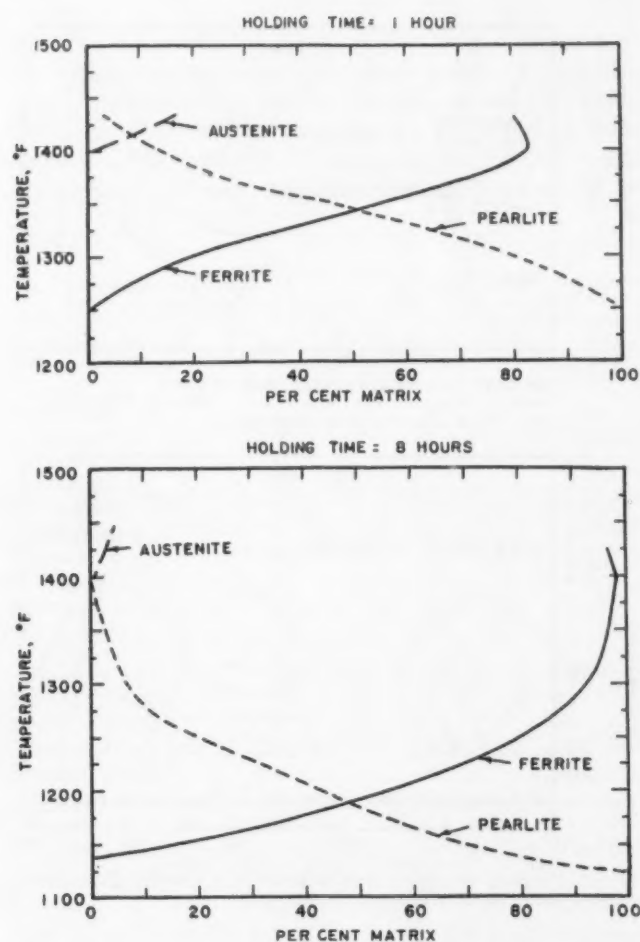


Fig. 15 — Per cent microconstituents present in cooled specimens of "E" iron isothermally transformed.

It seemed possible that one might heat over the critical temperature and achieve full or virtually full ferritization before an appreciable amount of austenite formed. This possibility was investigated by taking 1/8-in. slices as was done for the isothermally transformed cooled specimens, and heating them in a lead pot for one and eight hours at various temperatures.

At the end of the desired time, the specimens were quenched in water so that the formation of any austenite during the heat treatment might be detected. Both the high and low limits of the temperature range were higher than those used for the isothermal transformation of the cooled specimens. The lowest temperature used was 1320 F (715 C), because at lower temperatures the rate of ferritization would be appreciably less and of little interest. It was also found that for 1 hr treatments the maximum rate of ferritization was not reached at 1425 F (775 C), so temperatures up to 1475 F (800 C) were used.

A lineal analysis was made on the specimens, and the results are plotted in Figs. 16 and 17. To facilitate a comparison with the isothermal ferritization of cooled specimens the ferrite curves for that study are included. The graphs indicate an appreciable advantage for the reheated specimens insofar as the rate of ferritization is concerned, for the 1-hr treatments of both "B" and "E" irons. With the 8-hr heat treatments a definite advantage was shown for "B" iron, but with "E" iron the rates were the same for both

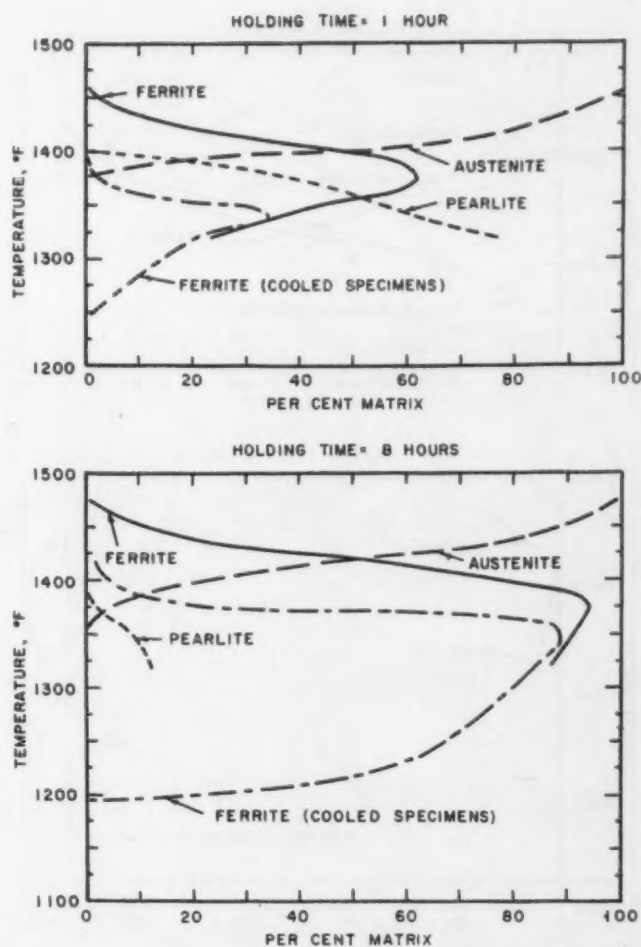


Fig. 16 — Per cent microconstituents in heated specimens of "B" iron isothermally transformed. Ferrite curve for cooled specimens included for comparison.

the cooled and reheated irons.

It was concluded on the basis of the data given above that the marked advantages of reheating on the rate of ferritization warranted a study of tensile specimens treated in a temperature range that included those temperatures which give maximum ferritization. Some doubt existed regarding a direct correlation between the per cent of ferrite and the ductility, because of a variation in the remaining part of the matrix. Take as an example the 1-hr treatment for "E" iron at 1450 F (790 C), at which the largest amount of ferrite is formed. The residual part of the matrix at this temperature is austenite which would change to relatively fine pearlite during cooling, while at 1425 F (775 C) the amount of ferrite would be somewhat less, but the remaining part of the matrix would be spheroidized pearlite. Hence maximum ductility might be obtained at temperatures below 1450 F (790 C).

The tensile properties were investigated by first normalizing from 1800 F (980 C) a number of "m" and "b" location blanks. In view of the limited number of temperatures to be used it was considered desirable to use two specimens, one each from "m" and "b" locations for each temperature. Also, because of the large amount of ferritization that occurred in the small specimens previously checked in 1 hr, it was planned to use this time for all tests.

The tensile specimen blanks were heated at the

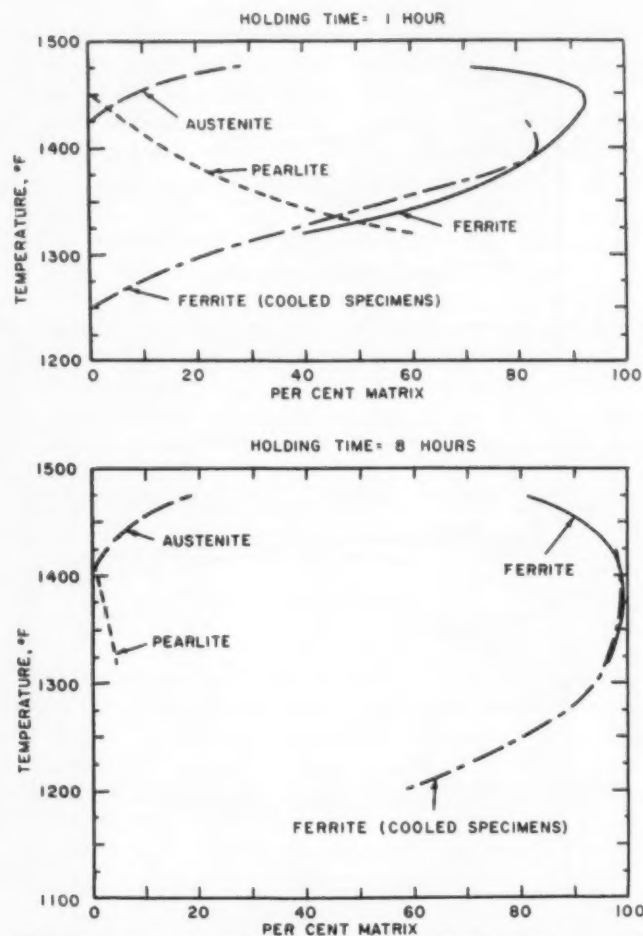


Fig. 17 — Per cent microconstituents in heated specimens of "E" iron isothermally transformed. Ferrite curve for cooled specimens included for comparison.

desired temperatures and then air cooled so as to allow any austenite present to transform to pearlite. The blanks were then machined, tested, and subjected to lineal analyses. The results are plotted in Fig. 18. "B" iron again showed its sensitivity to temperature but an elongation of 20 per cent was obtained in the short time of 1 hr at 1375 F (745 C). The relative insensitivity of "E" iron made it necessary to extend the temperature range to 1475 F (800 C). With "E" iron more than 20 per cent elongation was found with temperatures ranging from 1355 to 1450 F (735 to 790 C).

Considering the various maximum ductilities achieved with the different types of heat treatment studied it appears that about the maximum ductility that can be obtained is close to 22 per cent. Therefore it may be said that from the standpoint of tensile properties a good job of ferritizing both "E" and "B" iron may be accomplished in the short period of one hour.

IMPACT AND MISCELLANEOUS TENSILE TESTS

In many commercial applications where a high ductility type nodular iron is wanted, the ability of the iron to withstand impact loads might be a better measure of its value than a tensile test. There would appear little doubt that both maximum elongation in the tensile test as well as maximum impact ductility would be found in an iron which had a fully ferritic matrix. Some of the heat treatments previously dis-

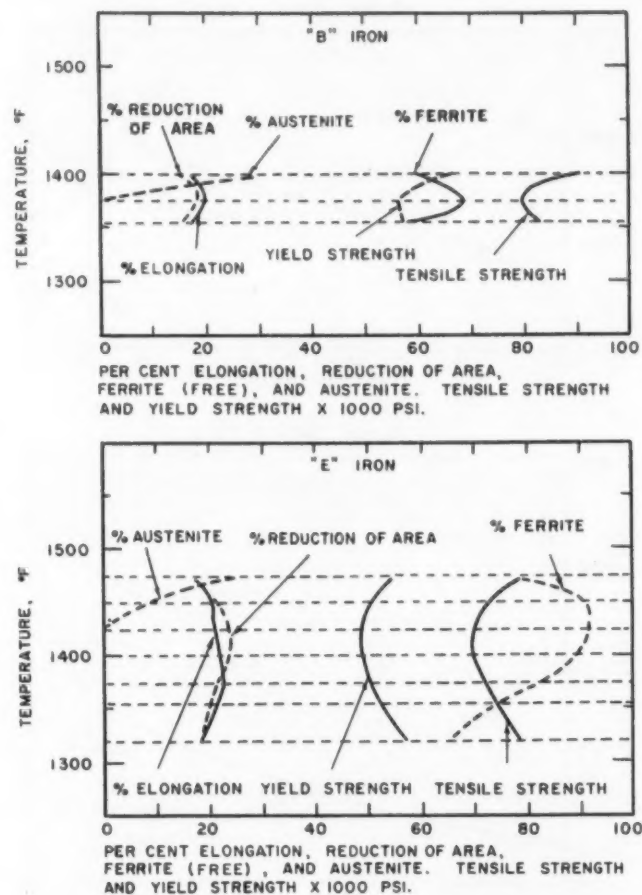


Fig. 18 — Effect of heating normalized specimens in lead pot at various temperatures.

cussed, however, have shown that a fairly large amount of dispersed carbide areas might be tolerated without appreciably lowering the tensile elongation. The best example of this characteristic is found in Fig. 18 of the preceding section, in which both "B" and "E" irons had elongations of 20 per cent with matrices containing only 70 per cent ferrite. With a maximum possible elongation of about 22 per cent it would appear that the last 30 per cent of dispersed carbide areas had little effect. It was therefore of interest to determine whether this same insensitivity would be found with regard to impact ductility.

The impact specimen design chosen and the test procedure used, are described in a preceding section.

As no data were available on the range of values or reproducibility that might be obtained with the specimen design adopted, it was decided to run first a series of specimens which would include the most brittle and most ductile states of the iron. For the first state, specimens normalized from 1800 F (980 C), and therefore having virtually a 100 per cent pearlitic matrix, were used; while for the last state it was most convenient to use specimens furnace cooled from 1800 F (980 C). Four specimens, two from each of the "b" and "m" locations, were tested for each of the two states. The results are given in Table 3. These tests gave a range of 3.5 to 64 ft-lb, which was considered wide enough to have adequate sensitivity.

The tests also indicated a relatively large sensitivity

to section location which had not been observed in the many tensile tests previously made. A metallographic examination of the furnace cooled "B" irons revealed that the "m" location did contain a little more pearlite than the "b" location, but the difference seemed insignificant considering the drop of 62 to an average of 24 ft-lb.

TABLE 3 — IMPACT TESTS ON NORMALIZED AND FURNACE COOLED IRONS FROM 1800 F (980 C)

Treatment	Iron	Location	Impact Value ft-lb
Normalized	"B"	"b"	7.0
Normalized	"B"	"b"	6.0
Normalized	"B"	"m"	3.5
Normalized	"B"	"m"	3.5
Normalized	"E"	"b"	13.5
Normalized	"E"	"b"	9.0
Normalized	"E"	"m"	12.0
Normalized	"E"	"m"	8.0
Furnace Cooled	"B"	"b"	62
Furnace Cooled	"B"	"b"	62
Furnace Cooled	"B"	"m"	26
Furnace Cooled	"B"	"m"	22
Furnace Cooled	"E"	"b"	64
Furnace Cooled	"E"	"b"	64
Furnace Cooled	"E"	"m"	53.5
Furnace Cooled	"E"	"m"	57.0

The marked location sensitivity raised the question as to whether further tests should be confined to location "b". Fortunately it was decided to continue testing "m" and "b" pairs, for most of the other treatments resulted in much less spread in impact values.

Evaluation of Isothermally Treated Reheated Irons

The fast response to ferritization in the isothermal treatment of reheated irons made this type of heat treatment of particular interest, and it was studied next. Based on Fig. 18 the optimum temperatures for ferritization were 1375 F (745 C) and 1425 F (775 C) for "B" and "E" irons respectively. After a normalize from 1800 F (980 C), specimen blanks were heated for 1/2, 1, 2, and 4 hr in lead pots at the given temperatures and air cooled. Charpy specimens were machined and tested, and the results are plotted in Fig. 19. Some austenite formed in the 1, 2, and 4-hr treatments of "B" and "E" irons, the latter iron having the greatest amount. Also, as would be expected, the amount of austenite increased with time.

During air cooling the austenite tends to transform to fine pearlite. The quantity of the fine pearlite in the "E" iron heat treated for 4 hr at 1425 F (775 C) was sufficient to cause its impact value to be less than that obtained with the 2-hr time. As there was some possibility that the maximum values obtained for both irons was lowered by the generation of fine pearlite, another series of specimens was run at lower temperatures for both irons, this time 1355 and 1400 F (735 and 760 C) being chosen. The impact values are plotted in Fig. 19.

The results show that the lower temperatures did not give as high impact values as the previous tests. From the slope of the curves, however, it seems possible that with longer times at lower temperatures higher values might eventually be reached.

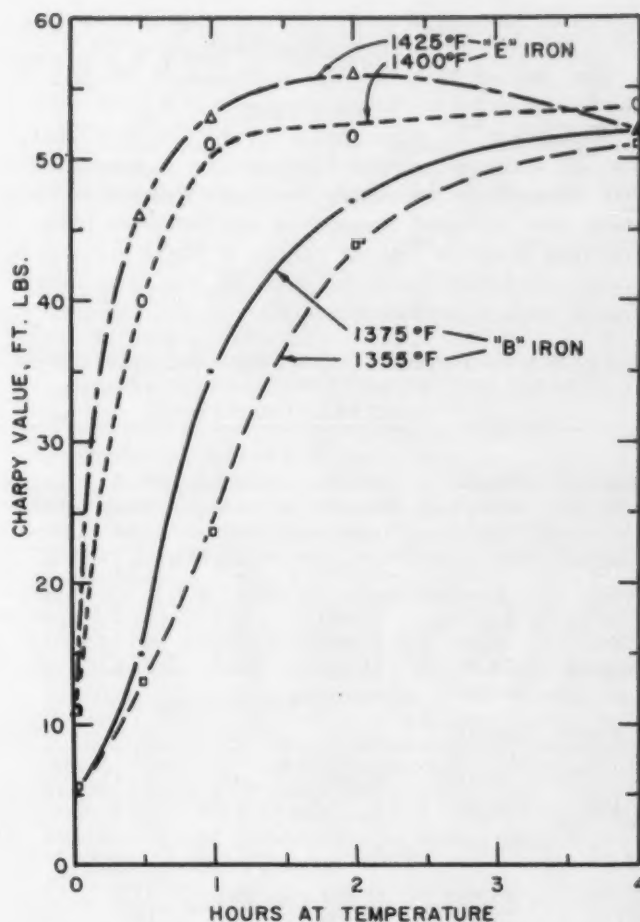


Fig. 19 — Charpy value versus reheat time in lead.

The greater sensitivity of the impact test to dispersed carbides is well illustrated by the "B" iron treatment of one hour at 1375 F (745 C). While such a treatment gave 20 per cent elongation (very near maximum) in the tensile test, the impact value was only 35 ft-lb. Figure 18 indicates that the matrix after this treatment is 70 per cent ferrite.

The impact values plotted in Fig. 19 are average values for "m" and "b" locations. The individual values are given in Table 4. These are included to show

TABLE 4 — IMPACT VALUES FOR CHARPY UNNOTCHED BARS AFTER ISOTHERMAL FERRITIZATION TREATMENTS

Iron	Location	Treatment Time hr	Treatment Temperature F	Impact Value ft-lb
"E"	"b"	½	1425	45
"E"	"m"	½	1425	47
"E"	"b"	1	1425	52
"E"	"m"	1	1425	54
"E"	"b"	2	1425	58
"E"	"m"	2	1425	54
"E"	"b"	4	1425	49
"E"	"m"	4	1425	54
"B"	"b"	½	1375	18
"B"	"m"	½	1375	12
"B"	"b"	1	1375	38
"B"	"m"	1	1375	32
"B"	"b"	2	1375	47
"B"	"m"	2	1375	47
"B"	"b"	4	1375	56
"B"	"m"	4	1375	48

the small amount of scatter between the two locations after the isothermal ferritization treatments.

The impact tests on the isothermally treated reheated irons led to the conclusion that 4 hr at 1375 F (745 C) for "B" iron and 2 hr at 1425 F (775 C) for "E" iron gave the best results. As no tensile tests had been made previously for these treatments, they were now run and the results are listed in Table 5 together with the impact values. A lineal analysis of these specimens gave 83 and 92 per cent ferrite for "B" and "E" irons respectively.

TABLE 5 — PROPERTIES OF IRONS FERRITIZED*
WITH AND WITHOUT PRIOR NORMALIZING
HEAT TREATMENT

Spec. No.	"E" Iron (Not Normalized)				
	Tensile Strength, psi	Yield Strength, psi	Elonga- tion, %	Red. Area, %	Impact Value ft-lb
ET89**	71,500	51,200	22.6	25.1	55
ET90	Unsound tensile specimen				40
ET91	71,200	51,600	22.6	24.5	49
ET92	70,700	51,600	22.6	18.1	51
Average	71,100	51,500	22.6	22.5	49
	"E" Iron (Normalized)				
	Tensile Strength, psi	Yield Strength, psi	Elonga- tion, %	Red. Area, %	Impact Value ft-lb
ET93**	67,800	47,700	24.0	23.8	58
ET94	67,700	47,600	22.6	23.8	54
ET95	68,000	47,800	24.0	24.8	—
ET96	67,700	47,700	21.3	20.9	—
Average	67,800	47,700	23.0	23.3	56
	"B" Iron (Not Normalized)				
	Tensile Strength, psi	Yield Strength, psi	Elonga- tion, %	Red. Area, %	Impact Value ft-lb
BT51**	75,500	58,300	18.7	21.2	23
BT52	74,800	57,000	18.7	18.0	41
BT53	75,700	57,500	20.0	21.2	41
BT54	75,200	56,400	20.0	21.2	49
Average	75,300	57,300	19.4	20.4	38.5
	"B" Iron (Normalized)				
	Tensile Strength, psi	Yield Strength, psi	Elonga- tion, %	Red. Area, %	Impact Value ft-lb
BT55**	75,800	50,500	20.0	20.9	56
BT56	75,300	51,600	20.0	22.0	48
BT57	77,200	51,200	20.0	20.9	—
BT58	76,500	50,200	20.0	19.8	—
Average	76,200	50,900	20.0	20.9	52

*"E" iron, 2 hr at 1425 F (775 C), and "B" iron, 4 hr at 1375 F (745 C).

**Specimen numbers apply to tensile specimens only.

Effect of Omitting Normalizing Treatment

In all the above heat treatments it was taken for granted that the normalizing treatment of air cooling after heating for 2-1/2 hr in a furnace operating at 1800 F (980 C) was necessary, and it was applied to all specimens. It appeared that the small amount of proeutectoid cementite that existed in the as-cast "B" iron might lower the ductility, and this constituent can be readily decomposed at a high temperature only. Furthermore, it has been reported by Gilbert⁶ that even when no proeutectoid cementite is present, the normalizing treatment is required for best ductility.

In a commercial operation the normalizing treatment would be a relatively expensive operation, and therefore it should be of interest to determine the extent of the benefit derived from it. To obtain this information a testing program was conducted in which impact as well as tensile tests were made for both "B" and "E" irons after the treatments of 4 hr at 1375 F (745 C) and 2 hr at 1425 F (775 C) respec-

tively, the normalizing treatment being omitted. The results are listed in Table 5.

Both "B" and "E" irons respond in a similar manner to the omission of the normalizing treatment. The tensile properties were affected little except for the yield strengths which were lowered by the normalizing treatment—"B" iron showing a drop of 6400 psi. and the "E" iron 3800 psi. The impact values were also lowered when the normalizing treatment was not used, and there was a considerable amount of scatter.

The relatively high sensitivity of the impact test to the exclusion of the normalizing treatment is not unexpected, for the test must be quite dependent on the microstructure found close to the surface on the tension side where cracks are initiated. Statistically there would be a greater variation in this localized region than over the larger area that would be affected in the tensile test. The diffusion accompanying the normalizing treatment would promote uniformity in the internal structure of the irons and thus reduce both the peak detrimentalities as well as their variation.

Impact Ductility of Ferritized Martensite

The tensile tests reported on ferritized martensitic structures (See Fig. 10) revealed that the secondary graphite gave relatively low elongation values when austenitization temperatures of 1800 F (980 C) and 1600 F (870 C) were used, but good values when the temperature was 1500 F (815 C).

During the survey of the various heat treatments with the impact test it was decided to include two specimen blanks from "m" location of "B" and "E" irons that had previously been normalized from 1800 F (980 C), reheated to 1500 F (815 C) for 2 hr, oil quenched, and tempered 1 hr at each of the temperatures 300, 650, and 1000 F (150, 340, and 540 C). They were now heated for 8 hr at 1340 F (725 C) to insure a high degree of ferritization, machined, and tested. Both specimens gave an impact value of 41 ft-lb, which is considerably less than the average values of 52 and 56 obtained by the isothermal treatment of the reheated specimens.

A check of the microstructures showed that both the "B" and "E" irons contained an appreciable amount of dispersed carbides. It is surprising that although the ferritization of martensite progresses with extreme rapidity at first, as illustrated by Fig. 9, it is still incomplete after 8 hr. The greater reluctance of the last portion of the carbides of the quenched specimens to ferritize as compared to those of specimens having had a slower prior cooling rate indicates that the faster cool probably prevents certain changes in the chemistry of the phases which are favorable for decomposition.

CONCLUSIONS

The original intent of this investigation was to study the effectiveness of various types of heat treatments with reference to ductility as represented by tensile elongation. Using this criterion it appears that the maximum or "ceiling elongation" of the two nodular irons tested fell between 20 and 23 per cent and could be achieved by all of the types of heat treatment,

providing certain temperature and time conditions were met.

On the other hand, the relatively abbreviated survey utilizing impact tests indicated a far greater sensitivity to treatment conditions—that is, conditions which gave the same elongation might produce very large differences in the impact values.

It is concluded that the two heat treatments which appear most attractive are: first, the controlled cooling rate through the eutectoid range, and second, the isothermal treatment of reheated specimens, both treatments being preceded by a high temperature hold. The two treatments gave essentially the same tensile properties, but the first treatment appeared to be capable of producing higher values of impact ductility and had a higher sensitivity to specimen location. The second treatment while not producing quite as high impact values as the highest reported for the first, gave much less scatter.

On the basis of the information brought forth by this investigation the isothermal treatment would appear most reliable. However, the fact that the more simple procedure of merely controlling the cooling rate through the eutectoid range gave higher as well as much lower impact values, makes this treatment very interesting because it is quite possible that a detailed investigation might reveal a procedure for elimination of the low values.

It is important to recognize that this investigation included only Charpy impacts at room temperature made on unnotched specimens. Additional studies that involved "V" notched specimens and lower temper-

atures might uncover important sensitivities which were not apparent in the results described above.

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This paper has been approved for presentation at the 62nd Annual Meeting of the American Foundrymen's Society, to be held in Cleveland, Ohio, May 19-23, 1958. The Society reserves all rights for publication either prior to or subsequent to presentation, and is not responsible for statements or opinions advanced herein.

WRITTEN DISCUSSION IS SOLICITED

MALLEABLE IRON MICROSTRUCTURES EFFECT AND CAUSE

REPORT OF AFS MALLEABLE DIVISION CONTROLLED ANNEALING COMMITTEE*

In response to an expressed need, the Controlled Annealing Committee 6D of the American Foundrymen's Society has combined in an effort to set forth both the basic microstructures commonly found in malleable iron metallurgy as well as some of the abnormal structures arising from known causes.

The literature contains an abundance of records and reports covering special phases of the technology, but no recent effort has been made to collect and present the normal structures in a single paper. The committee believes that such a collection will serve a purpose useful to both malleable founders and engineers associated with the use of malleable iron castings. If the understanding of the basic metallurgy involved in the annealing of malleable iron is thereby promoted, the committee feels that its efforts will have been well rewarded.

This report contains illustrations of various microstructures encountered in the respective committee member's companies. An attempt has been made to explain the causes which produced the effects shown in the photomicrographs. It is hoped that this will stimulate interest in and bring forth some discussion of malleable iron metallography.

Figures 1A and 1B show a typical ferritic malleable microstructure at $\times 100$ and $\times 500$. Note the complete absence of residual pearlite or cementite and the random distribution of MnS (light gray particles). There may or may not be a preferred orientation of temper carbon nodules. Such a pattern results from the decomposition of the dendritic primary carbide taking place on preferred planes. The nodule shape as shown in Fig. 1B is similar to that of a cockle-burr. Essentially, it is not spheroidal.

Figure 2 (A, B, C, D) illustrates four types of acceptable rims. Figure 2A shows the complete absence of pearlite. Nodules are within 0.010 in. at the surface. Figure 2B shows a discontinuous pearlitic rim approximately 0.007 in. in thickness underlaying a ferritic rim of about the same thickness. Note that in Figs. 2A and 2B the nodule shape, size, and distribution are similar.

Figure 2C shows a heavier pearlitic rim of approxi-

mately 0.018 in. underlaying a ferritic skin of approximately 0.007 in. Note that the ferritic outer layer is approximately the same thickness as that shown in Fig. 2B. However, the nodules are larger in size, more sprawling, and fewer in number. The presence of a patch of core pearlite as well as the entire retarding effect results from an increased denodulizing tendency or increased heating rate during the anneal.

Figure 2D shows a continuous pearlitic rim with no ferritic skin. Such a structure usually indicates an excessive reducing atmosphere.

In the four illustrations of Fig. 2, the basic chemistry and overall annealing cycle is the same. The effects result entirely from variations in control of atmosphere and rate of heating.

Figures 3A and 3B show the microstructures at the surface of similar castings illustrating the effects of differences in atmosphere control on denodulizing tendency.

Figure 4A shows the microstructure of an oxidized surface. Note the non-uniform surface and increased depth of penetration. Figure 4B shows oxidation of an internal shrink.

Figure 5 shows the microstructure of a mottled rim sometimes referred to as "inverse chill" and is a precipitation of flake graphite during freezing. This effect is generated in the mold and does not result from variations in annealing or atmosphere control.

Figure 6A shows the microstructure of a sprawling nodule. Note that the size and sprawliness of the nodules increase simultaneously. Figure 6B shows the microstructure of a normal compact nodule.

Figure 7 shows an example of high nodule count. This generally is considered excessive with a tendency toward lower mechanical properties.

Figure 8 shows an example of low nodule count. Such a condition frequently results in poor surface finish in rough machining.

Figures 9A through 9F illustrate the effect of increasing boron addition on nodule size and distribution. As increasing amounts of boron are added, nodule count increases and the shape compacts. In the higher concentration a preferred dendritic orientation occurs which is generally regarded as unfavorable in its effect on mechanical properties. This series was performed on the same basic iron.

Figure 10 shows the structure resulting from incom-

*Members of Controlled Annealing Committee are: L. R. Jenkins, *Chairman*; W. J. Amsbary; J. T. Bryce; L. E. Emery; P. W. Green; G. B. Mannweiler; C. R. Sorensen; Wm. A. Zeunik.

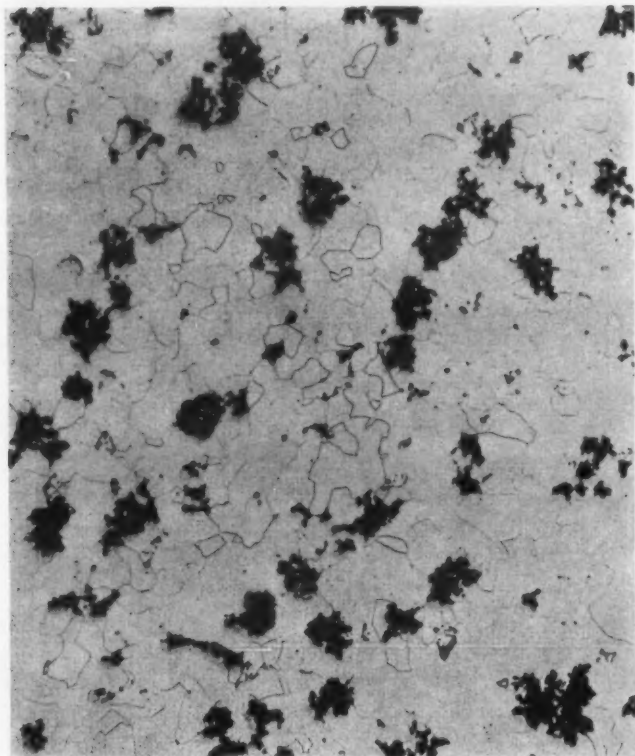
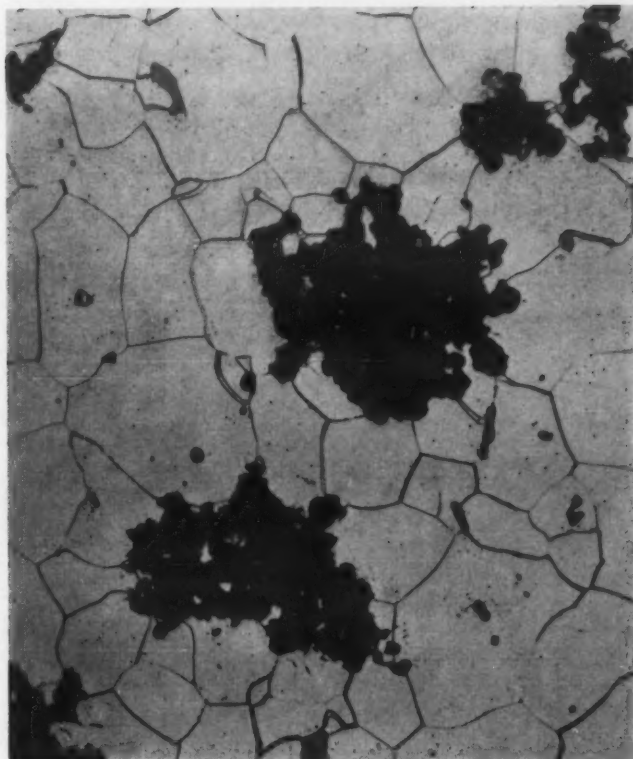
A—Nital etch. $\times 100$.B—Nital Etch. $\times 500$.

Fig. 1 A and B—Typical ferritic microstructures. Residual pearlite or cementite are completely absent. Light gray particles are MnS.

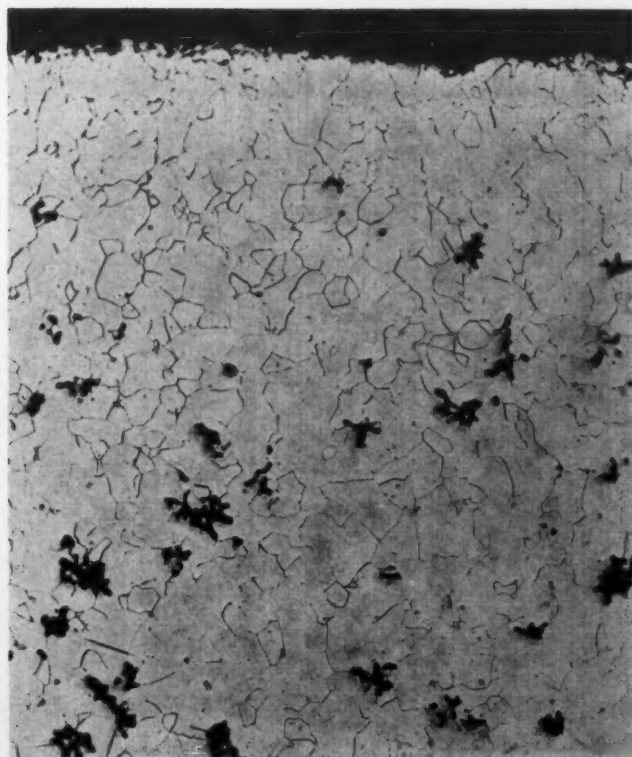
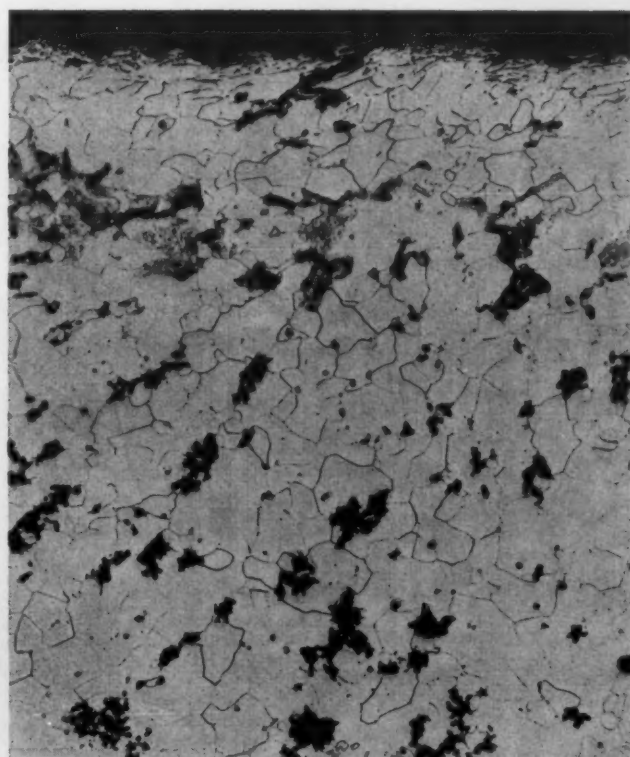
A—Nital etch. $\times 100$.B—Nital Etch. $\times 100$.

Fig. 2 A, B, C, D—Four types of acceptable rims. A—Complete absence of pearlite. B—Discontinuous pearlitic rim. C—Heavier pearlitic rim of approx. 0.007 in. D—Continuous pearlitic rim with no ferritic skin.

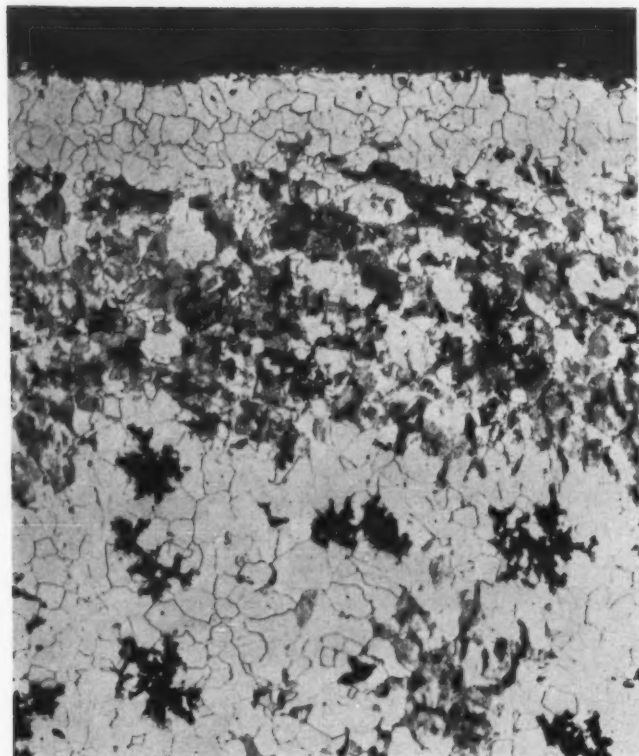
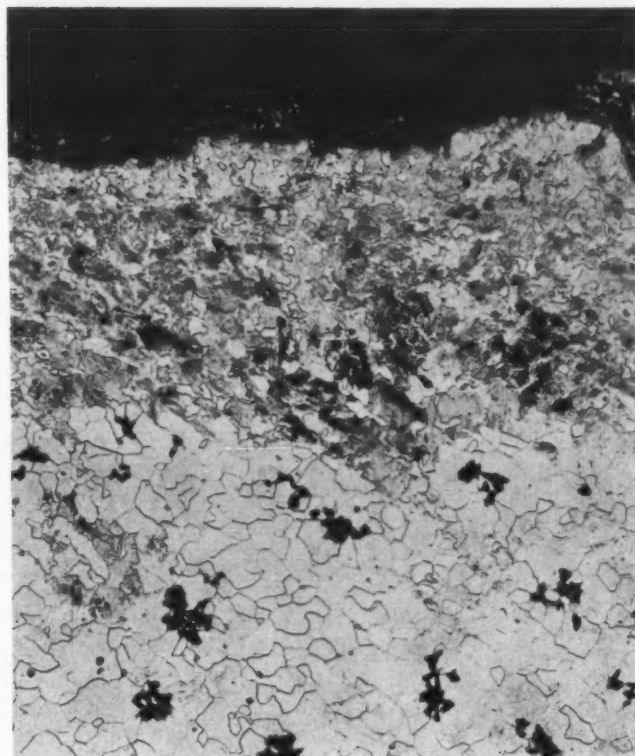
C—Nital Etch. $\times 100$.D—Nital etch. $\times 100$.

Fig. 2—Continued

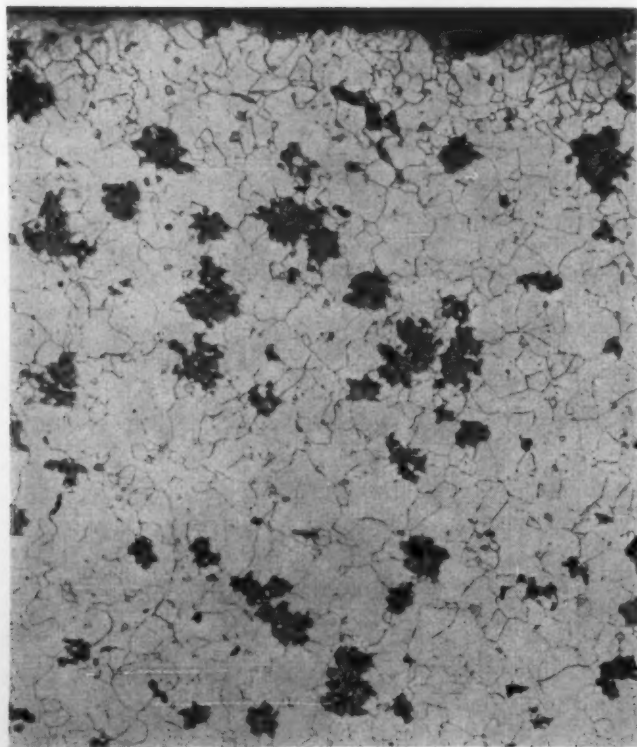
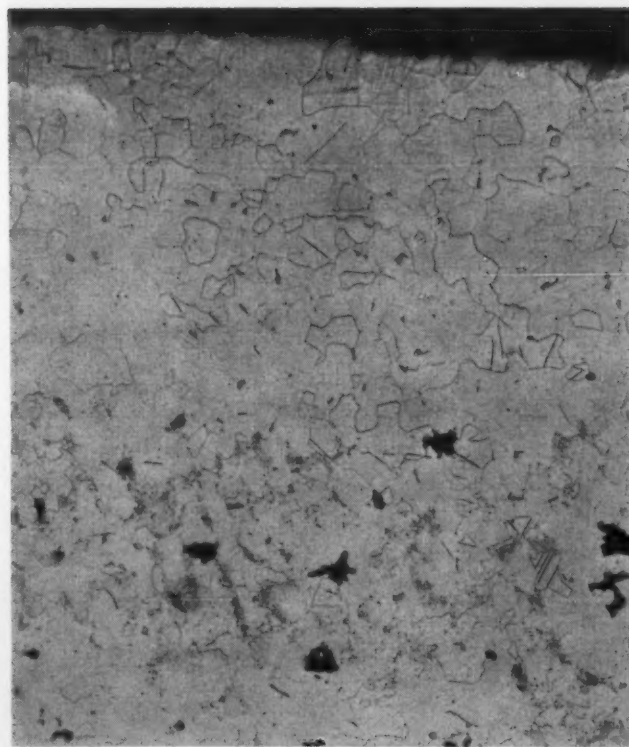
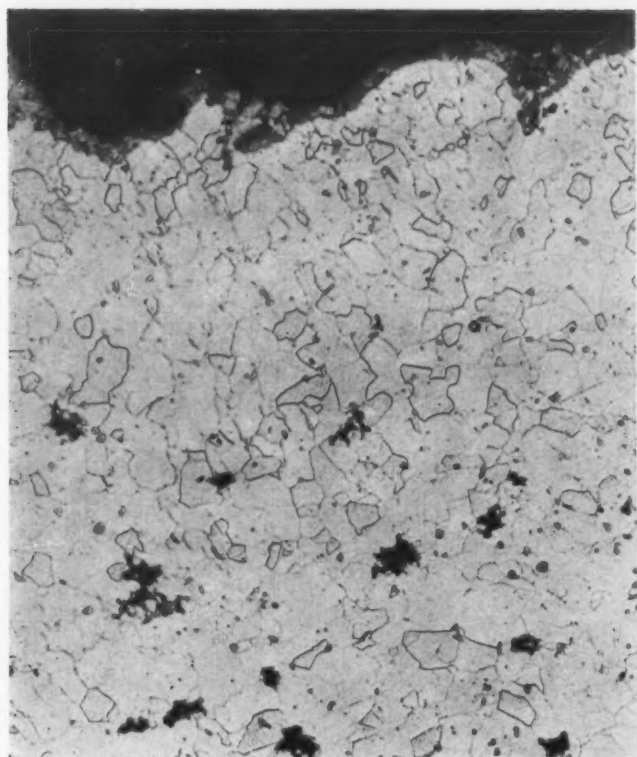
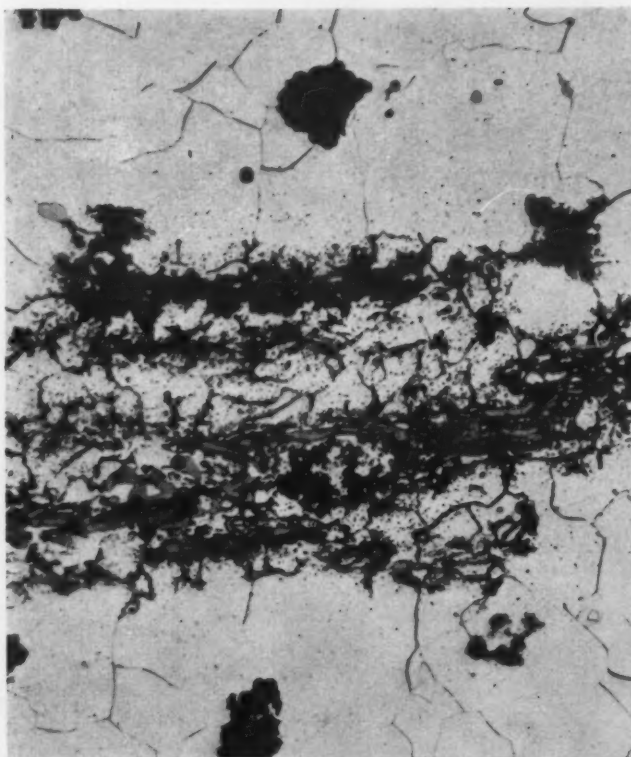
A—Nital etch. $\times 100$.B—Nital etch. $\times 100$.

Fig. 3 A and B—Microstructures at the surfaces of similar castings illustrating effects of differences in atmosphere control on denodulizing tendency.



A—Nital etch. $\times 100$.



B—Nital etch. $\times 100$.

Fig. 4 A and B—A—Microstructure of an oxidized surface, with non-uniform surface and increased depth of penetration. B—Oxidation of an internal shrink.

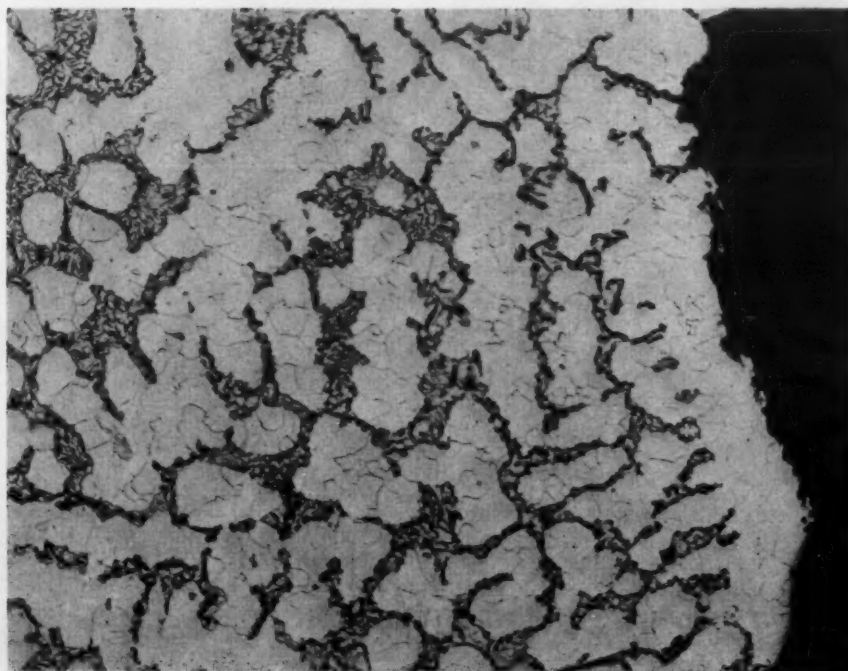
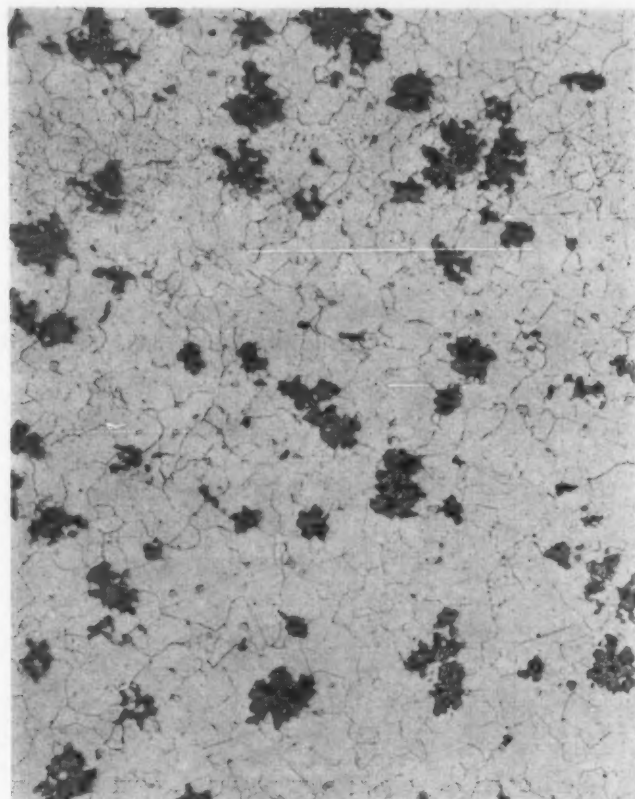


Fig. 5—Microstructure of a mottled rim (also called "inverse chill") as a result of precipitation of flake graphite during freezing. Nital etch. $\times 100$.



A—Nital etch. $\times 100$.



B—Nital etch. $\times 100$.

Fig. 6 A and B—A shows microstructure of a sprawling nodule. B shows microstructure of a normal compact nodule.

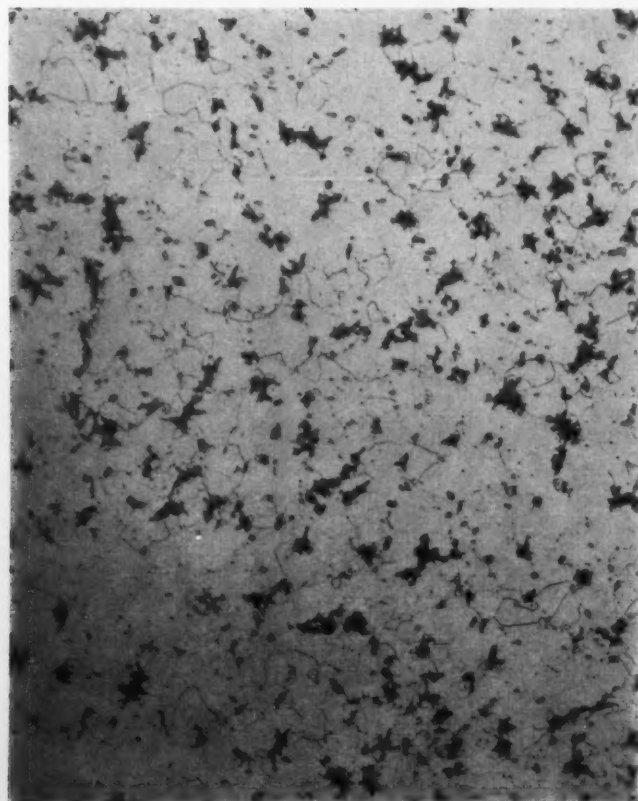


Fig. 7—This photomicrograph shows an example of high nodule count. Nital etch. $\times 100$.

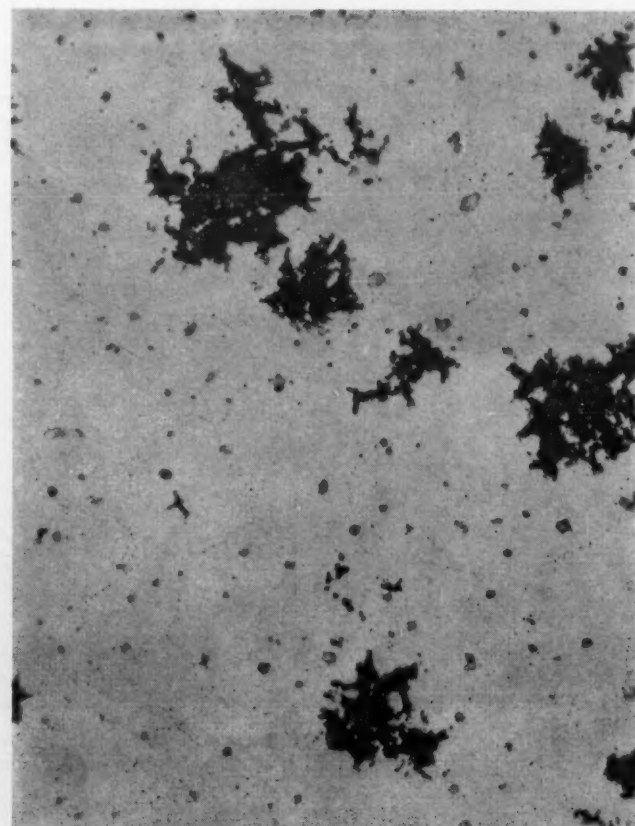


Fig. 8—An example of low nodule count is shown in this photomicrograph. Nital etch. $\times 100$.

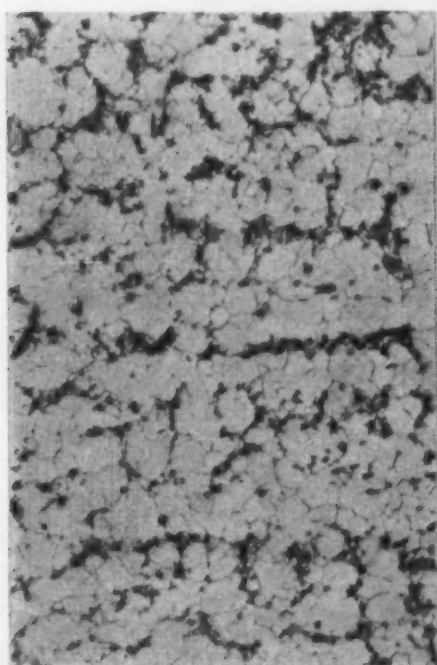
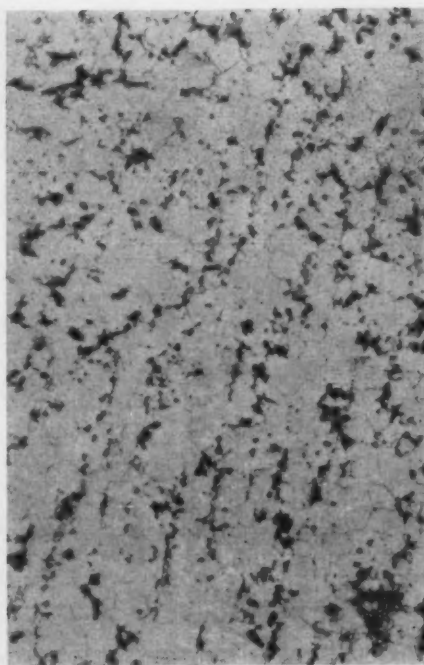
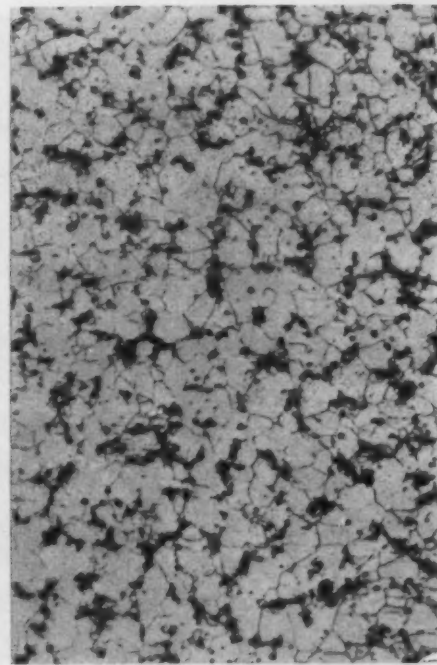
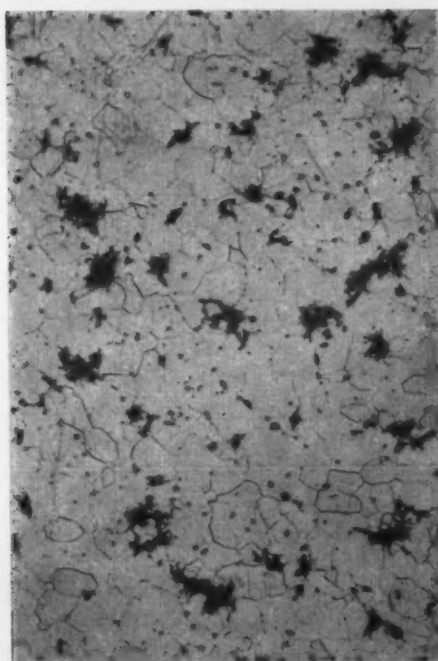
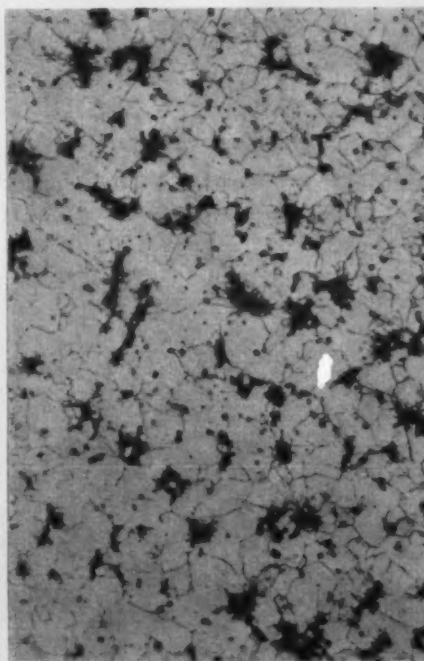
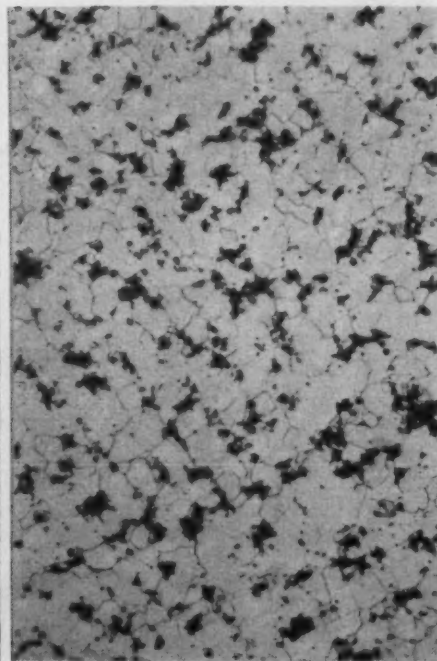
A—0.001% boron. $\times 100$.B—0.002% boron. $\times 100$.C—0.004% boron. $\times 100$.D—0.006% boron. $\times 100$.E—0.008% boron. $\times 100$.F—0.010% boron. $\times 100$.

Fig. 9— (A through F)—Photomicrographs illustrating effects of increasing boron additions on nodule size and distribution. As increasing amounts of boron are added, nodule count increases and the shape compacts.

plete first stage of annealing. Remnants of massive primary carbide are the significant indicators of this condition.

Figure 11 shows incomplete second-stage annealing. In this particular case, low carbon in the iron (2.15 per cent) resulted in heavy residual pearlite in the core structure. This condition would be difficult to pick up by means of hardness test due to the soft ferritic skin. This casting tested 149 Bhn.

Figure 12 illustrates incomplete first- and second-stage annealing. Note the presence of primary carbide,

coarse pearlite, and a sprawly nodule shape. This effect is caused by nonstandard chemical analysis of the iron.

Figure 13A shows the occurrence of shrinkage in hard iron. Note the characteristic dendritic pattern of the primary carbide. The general resistance of shrink areas to normal annealing is illustrated in Fig. 13B, as shown by the presence of residual pearlite. Residual carbide may also be present. Shrinkage is fundamentally a feeding problem and does not result from variations of heat treatment.

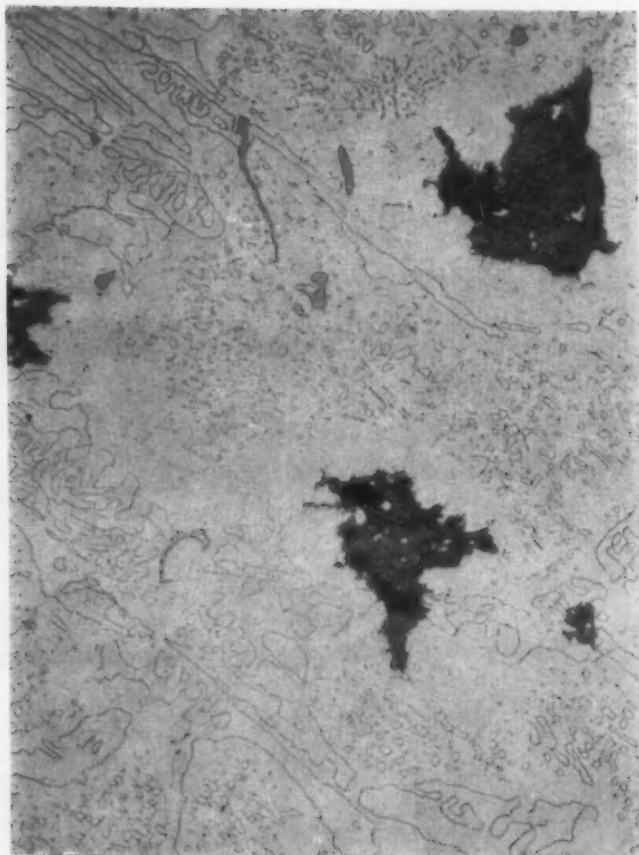


Fig. 10—Structure resulting from incomplete first-stage annealing. Nital etch. $\times 500$.

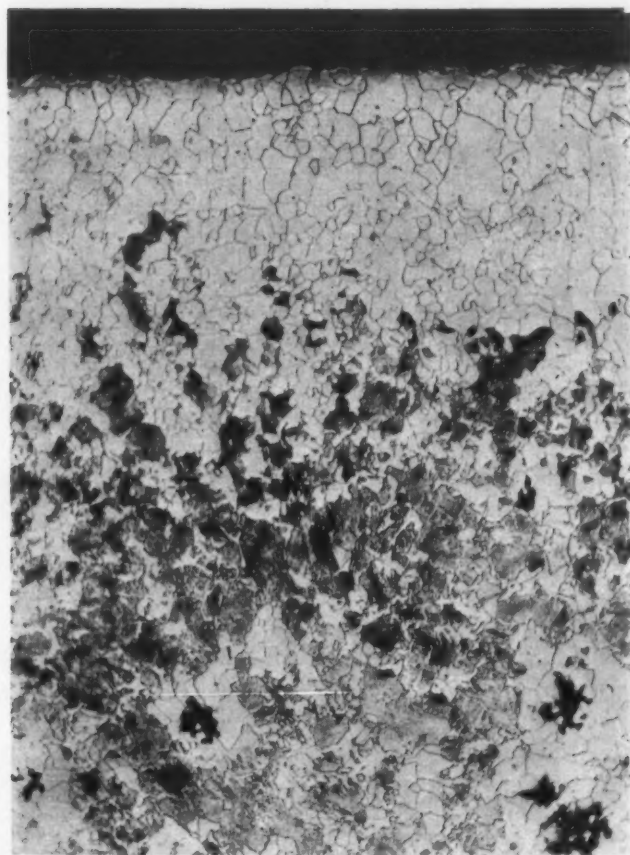


Fig. 11—An example of structure resulting from incomplete second-stage annealing. Nital etch. $\times 100$.

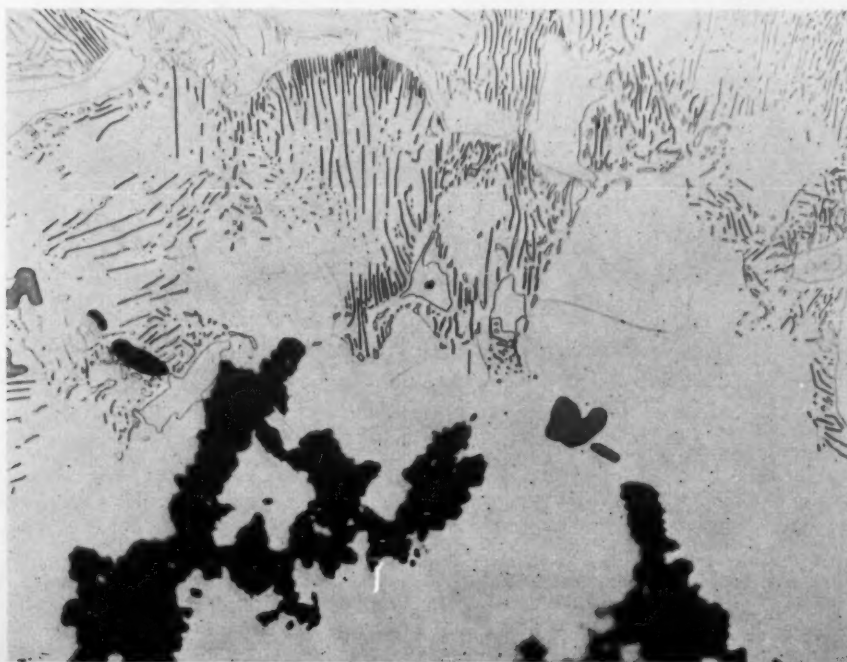


Fig. 12—Structure resulting from incomplete first-stage and second-stage annealing. Primary carbide, coarse pearlite and a sprawly nodule shape are shown. Nital etch. $\times 500$.

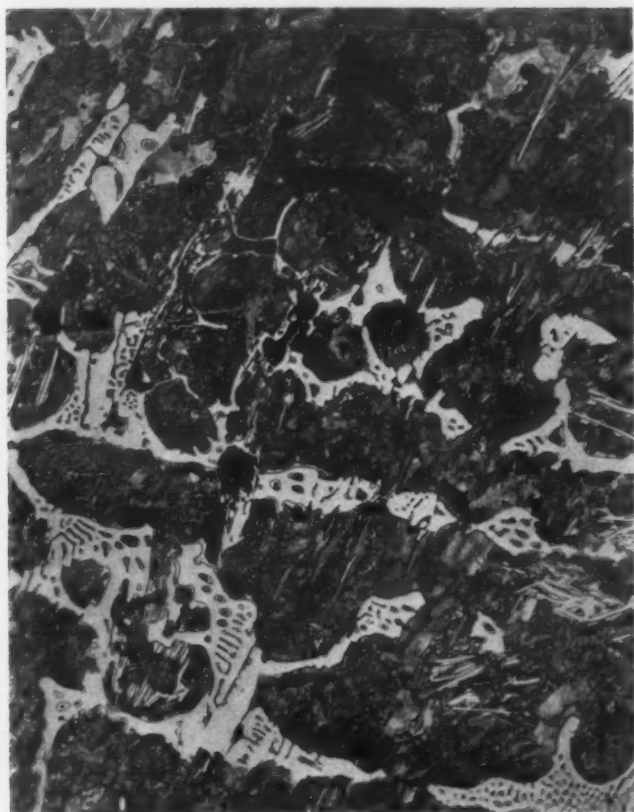
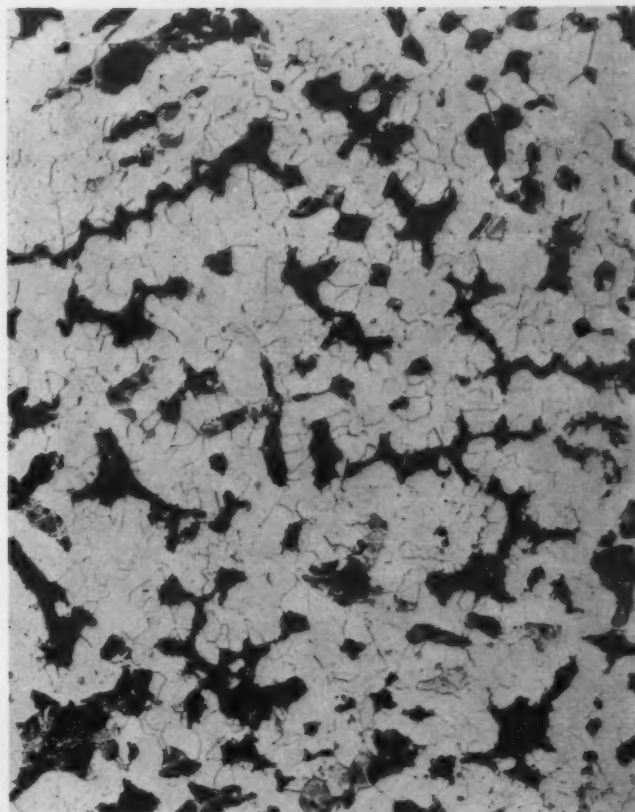
A—Nital etch. $\times 500$.B—Nital etch. $\times 100$.

Fig. 13 A and B—A shows the occurrence of shrinkage in hard iron. B—General resistance of shrink areas to normal annealing is shown by presence of residual pearlite.

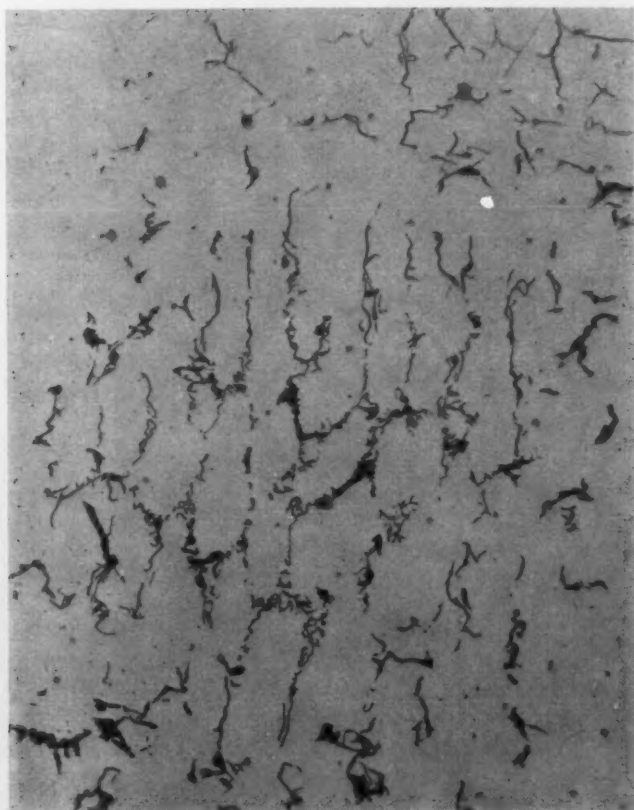
A—Unetched. $\times 100$.B—Unetched. $\times 100$.

Fig. 14 A and B—Phenomenon of mottle in hard iron (A), and in annealed iron (B).

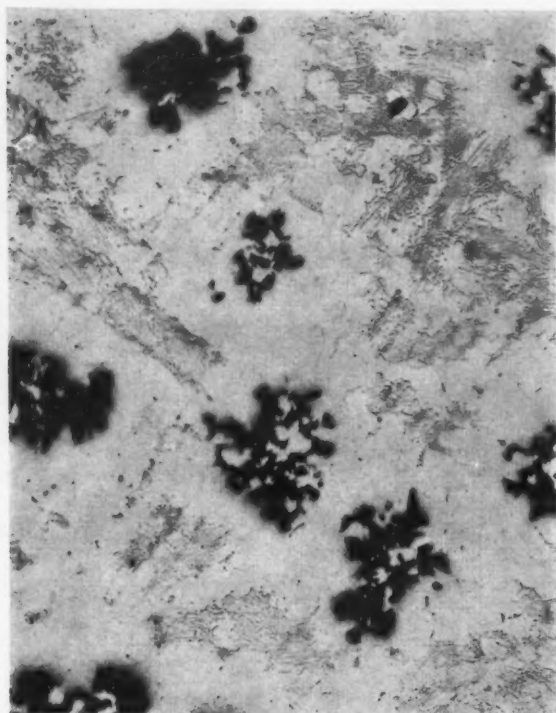
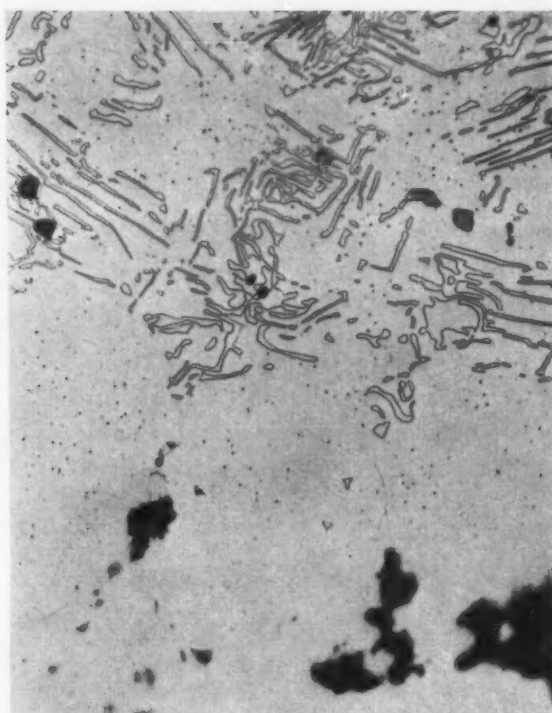
A- $\times 100$.B- $\times 500$.

Fig. 15 A and B—These photomicrographs illustrate the effect of low manganese on the resulting annealed structure.

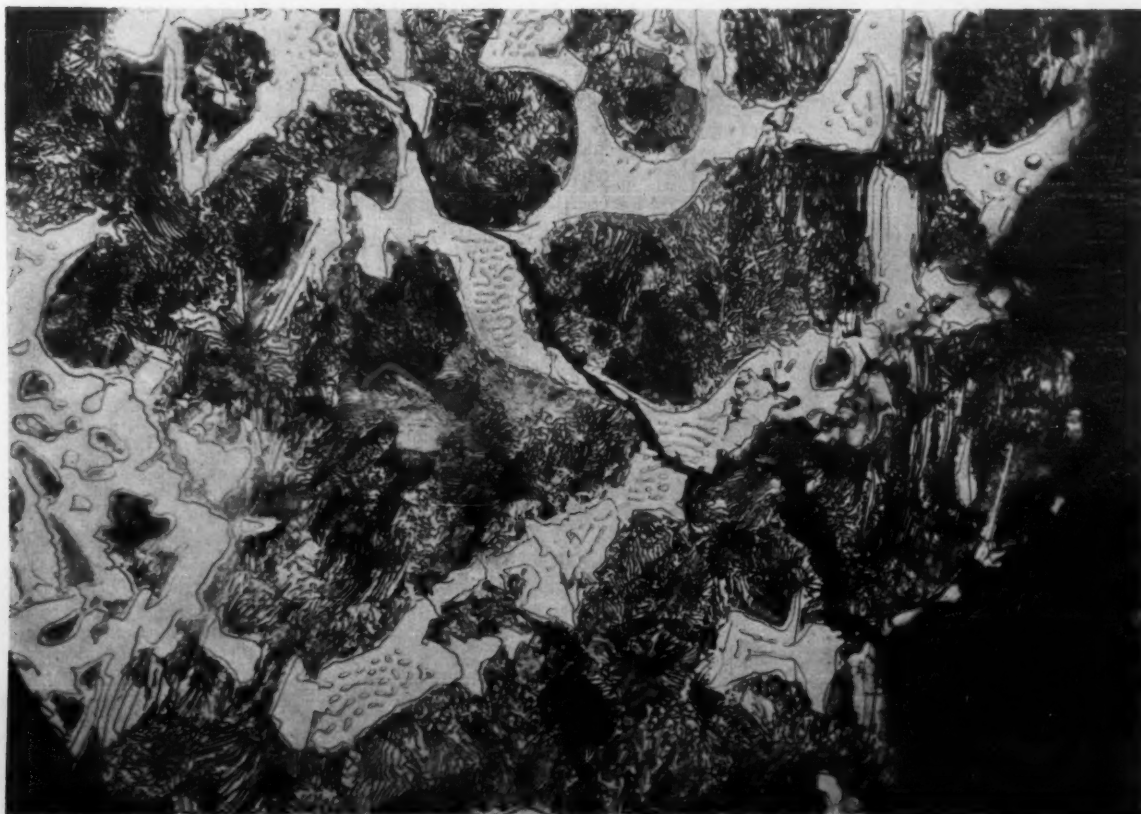


Fig. 16—This photomicrograph shows a hard iron crack. The crack tends to follow the interface between primary carbides and pearlite. Nital etch. $\times 500$.

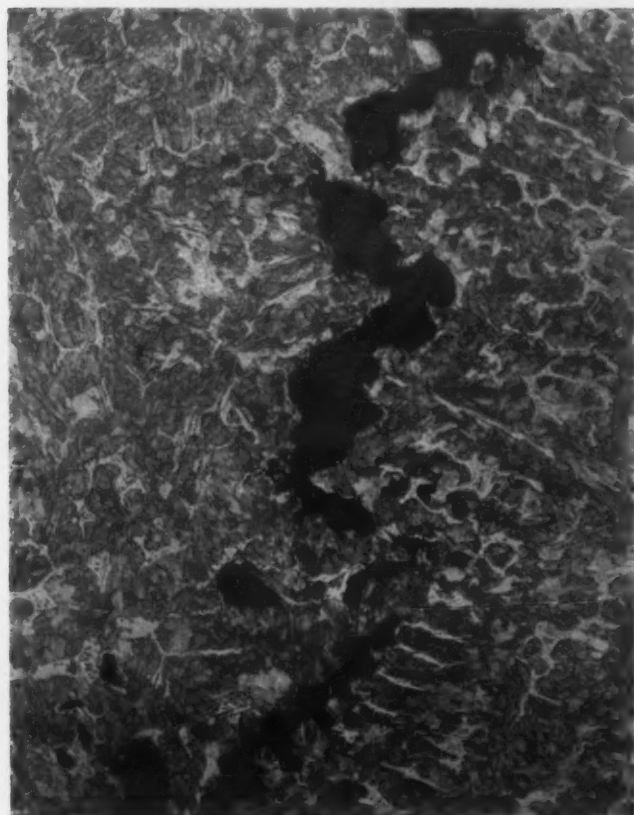


Fig. 17—The photomicrograph shows a crack in hard iron which aligns itself to voids having the appearance of shrinkage. Nital etch. $\times 100$.

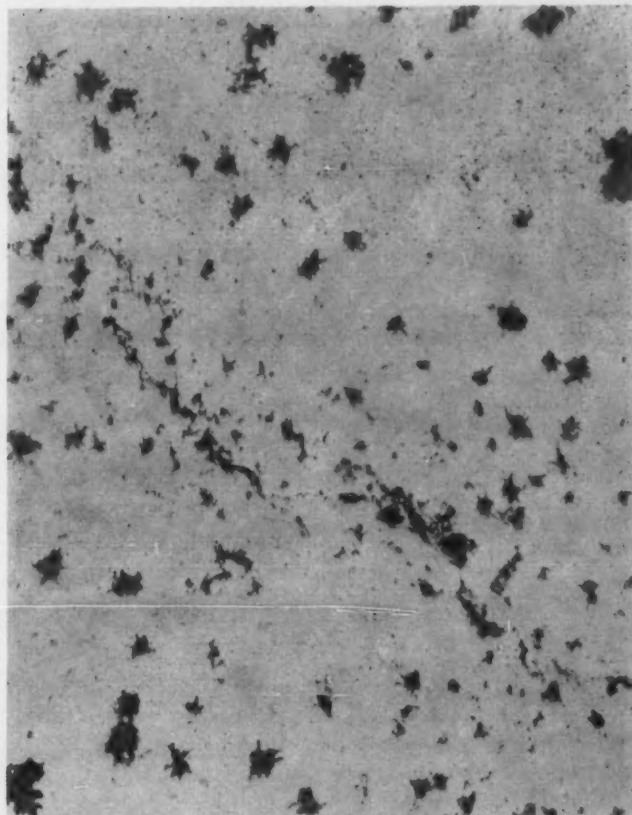
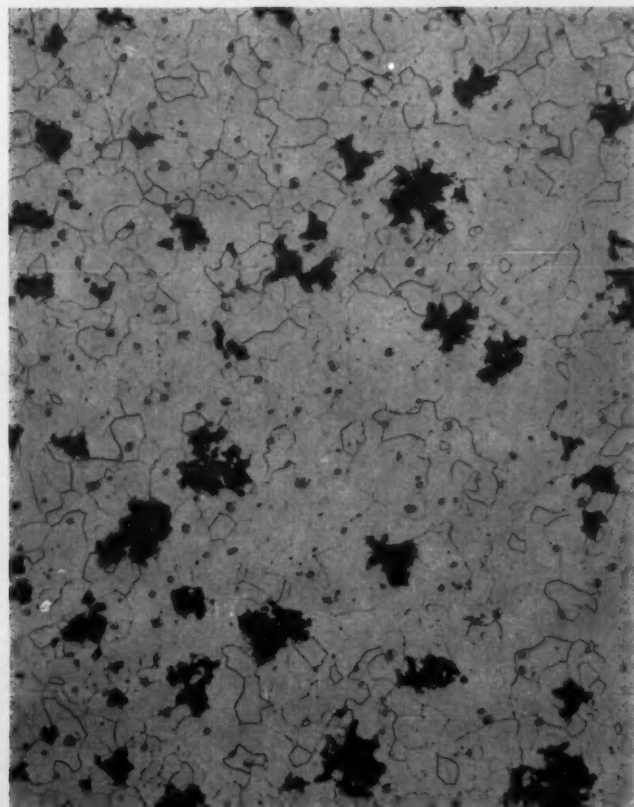
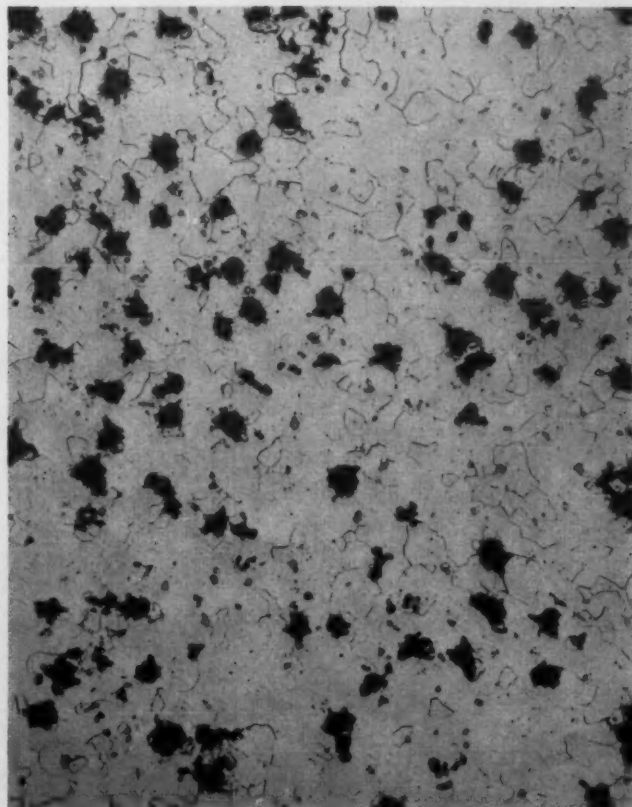


Fig. 18—Illustration of a "so-called" crack which does not show the continuous separation of metal. Unetched. $\times 100$.



A—Nital etch. $\times 100$.



B—Nital etch. $\times 100$.

Fig. 19 A and B—Effects of preheating hard iron 5 hr at 700F. A—Normal microstructure without preheat treatment. B—Increased nodule formation resulting from addition of pre-anneal treatment.

Figures 14A and 14B illustrate the phenomenon of mottle in hard iron (Fig. 14A) and in annealed iron (Fig. 14B). Mottle is the precipitation of flake carbon on freezing in the mold and its presence does not relate to heat treatment. Because of its depletion of combined carbon in hard iron, the structure surrounding the mottle frequently does not respond completely to normal heat treatment, as shown in Fig. 14B. Islands of residual cementite are clearly evident in the unetched structure. Mottle is always injurious to the mechanical properties of the casting.

Figures 15A and 15B illustrate the effect of low manganese on the resulting annealed structure. The carbides appear quite coarse, and result from inadequate second-stage annealing since the primary carbides have been completely dissolved. Manganese content is 0.33 per cent and the sulfur is 0.128 per cent. An increase in the manganese to 0.38 per cent would have permitted a normal annealing response.

Figure 16 shows a hard iron crack. Note the tendency of the crack to follow the interface between the primary carbides and pearlite. This crack extended less than 1/32-in. and was apparently caused by high internal stress in the casting.

Figure 17 shows a crack in the hard iron which aligns itself with voids having the appearance of shrinkage. There is a pronounced tendency for the crack to align itself in the orientation of the dendritic cementite pattern.

Figure 18 illustrates a so-called "crack" which does not show the continuous separation of metal. Such defects are noticed in fluorescent-penetrant inspection. Along the "crack" interface, nodule count is extremely high. This condition is presumed to have been caused by the high internal stresses which produced the crack.

Figures 19A and 19B show the effects of preheating hard iron 5 hr at 700 F. The chemical analysis and

heat treating cycles of both specimens are identical. Figure 19A shows the normal microstructure without preheat treatment, Figure 19B shows the increased nodule formation resulting from the addition of the pre-anneal treatment.

CONCLUSIONS

The illustrations contained herein are not intended as standards, but may be used as guides. They are representative of good normal practice, with some metallurgical defects included.

No attempt has been made to answer involved specialized problems in any phase of malleable iron heat treatment.

As originally indicated, no claims are made for this collection of photomicrographs to be a complete treatise on all of the metallurgical troubles which can beset the malleable iron foundry. Of course, troubles may always arise in any foundry from peculiarities of behavior of individual pieces of production and control equipment. In general, we have tried to avoid consideration of the type of structure resulting from "freak" conditions occurring in a single plant.

Ferritic malleable iron is an established engineering material of well-known properties and application. It has characteristic edge structures and core structures. These we have shown with the variations and explanations for the variations. Some of the variations are significant, some inconsequential. It is exactly on this difference that the focal point of this paper rests. To those not too familiar with the details of manufacture of malleable iron, the structures shown in this presentation may act as a guide. They are not intended as standards but are representative of what may happen in normal practice. They do show some of the defects which may develop when the processing goes out of metallurgical control.

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AFS Board Paves Way for Future Progress of Society

Orders By-Laws Ballot Sets Up 7 AFS Regions

Elects New Officials . . . Approves Progress to Date

Acting at the midyear meeting held Feb. 24-25, the AFS Board of Directors reviewed and approved the Society's progress in the current fiscal year and adopted several measures calculated to strengthen its technical programs and industry relations. At the same time, final plans were outlined for the huge Castings Congress and Foundry Show to be held in Cleveland, May 19-23.

Directs By-Laws Ballot

For the fourth time in fifteen years, the Board ordered a letter ballot of the membership on a general revision of the Society's By-Laws, to become effective July 1. Stressing the need to maintain flexibility of operations, the Directors approved recommendations of a special By-Laws Committee appointed by President H. W. Dietert, calling for changes in 16 of the present 22 articles.



Clyde A. Sanders

Primary reason for the by-laws revision was to make legal provision for the AFS Training & Research Institute, organized in December 1956 and originally announced in the January 1957 issue of MODERN CASTINGS. Outstanding success of practical training courses staged by the Institute in Chicago, Detroit, Milwaukee, San Francisco and Hamilton, Ontario, was reported by H. Bornstein, T&RI Trustee chairman, and the need for an ever-broadening course schedule in the years ahead.

Institute Recommendations

Eventually it is intended to construct a Foundry Training Center building on AFS property in Des Plaines, Ill., equipped with foundry laboratory as well as facilities for instruction in physical, chemical and metallurgical testing of cast metals. Additional land has already been acquired for necessary off-street parking.



Richard A. Oster

Present plans call for conducting training courses 32 weeks each year in the proposed new building.

In presenting the Institute's first annual report of operations, Chairman Bornstein presented recommendations of the Trustees that the AFS Board now proceed with the Foundry Training Center plan, in view of the success of courses held to date and their growing acceptance. Detailed floor plans and architectural specifications were offered, and cost estimates of construction and installation. The Board of Directors recommended that actual construction be deferred in view of existing business conditions, and that more detailed estimates of cost, financing and building utilization be prepared in the meanwhile.

Eventually the Society and Institute hope to construct a new "Foundry Training Center" building on AFS property in Des Plaines, Ill., where additional land has already been acquired for necessary off-street parking. Present plans are to conduct training courses in the new building on a wide



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National News

variety of subjects some 32 weeks each year, utilizing foundry and other built-in laboratory facilities.

Major Revisions Proposed

Other major changes in the Society's by-laws concern the Regional organization, duties of officers, procedures for nominating officers and directors, and organization of the Central Office Staff. The original five Regions of AFS have now been increased to seven, each Region headed by a Regional Vice-President as the Society's "official representatives" therein.

Further changes in the nominating procedures re-emphasize the important role of the Chapters in Society affairs. The new by-laws proposals should make the nominating function more positive, equitable and democratic.

Several important revisions clarify Staff functions and their relation to Board functions. It is proposed that the Board elect four Staff officers henceforth: a General Manager as the chief administrative officer; a Secretary, a Treasurer, and a Technical Director. In the past, only the Secretary and Treasurer have been elected. The new by-laws spell out the necessary "chain of command" and prescribe more clearly the respective duties of Board and Staff officials.

Members Should Vote Promptly

By order of the Board, a letter ballot of the membership was mailed in mid-March and all ballots to be counted must be received in the Society's Central Office by April 28. The membership has been urged to vote promptly, a heavy ballot being anticipated.

AFS Regions Reorganized

The Society's Regional organization was established in the December 1953 by-laws amendment primarily to relieve the President and Vice-President of excessive official time demands, and to develop better communication between all elements of the Society by giving opportunity for the members at all levels to be heard. The plan has been well received, especially the holding of Regional

Administration meetings of national Directors and Chapter officers.

The original five Regions were set up with more or less equality of chapter membership totals in mind, within geographical limits. Since then, four new AFS Chapters have been chartered in Region No. One, making that area somewhat "top heavy." As a result, the Board has now increased the number of Regions to seven, each headed by a Regional Vice-President, all of whom are members of the Board's Executive Committee. Each will hold at least one Regional Administration meeting annually with their fellow Directors and Chapter Chairmen and Vice-Chairmen.

New Officials Chosen

The by-laws amendment of 1953 increased the AFS Board to 24 officers and directors, six directors being selected annually by the Nominating Committee, one annually by the Board. The latter, a Director-at-Large, enables the selection of executives not able to serve actively in Chapter or technical committee work.

Nominees for 1958 selected by the Nominating Committee were announced in the February MODERN CASTINGS.

Clyde A. Sanders, vice-president of American Colloid Co., Chicago, has been elected by the Board as the 1958 Director-at-Large to serve a 3-year term commencing May 24. Long active in AFS technical activities, especially in the Sand Division, and a past chairman of the Chicago Chapter, Sanders received the John H. Whitling Gold Medal of the Society in 1957 for outstanding contributions to the Society and the industry.

Richard A. Oster, director of the Vocational and Adult School at Beloit, Wis., has been elected by the Board as a Trustee of the Training and Research Institute. A past chairman of the Northern Illinois-Southern Wisconsin Chapter, and currently completing his term of office as a national Director, Oster will serve T&RI as a Trustee for a 4-year term commencing in May. He replaces Dr. G. H. Clamer, Ajax Metal Div. of H. Kramer & Co., Philadelphia, one of the organizing Trustees.

Wm. D. Dunn, assistant to the president, Oberdorfer Foundries, Inc.,

Syracuse, N. Y., has been appointed one of the two AFS members of the Foundry Educational Foundation's board of Trustees. His 2-year term will be 1958-1960, replacing O. J. Myers, Reichhold Chemicals, Inc., White Plains, N. Y. The second AFS trustee is A. V. Martens, Pekin Foundry & Mfg. Co., Pekin, Ill., serving 1957-1959.

Other Board Discussions

Progress of the two latest technical Divisions of the Society, the Die Casting and Permanent Mold Division and the Ductile Iron Division, was reviewed and their initial 1958 Convention programs outlined. Directors C. E. Nelson, Dow Chemical Co., Midland, Mich., and C. W. Gilchrist, Cooper-Bessemer Corp., Mt. Vernon, Ohio, told of steps taken in developing both activities.

Resolutions of the Foundry Equipment Manufacturers' Association relating to frequency of AFS exhibits were read by President Dietert. The Board, in deferring action, requested that a comprehensive study be prepared of the entire activity, for later consideration.

Select Official Exchange Paper for International

A paper dealing with light metal sand castings has been selected as the Official Exchange Paper from the American Foundrymen's Society to the International Foundry Congress.

The exchange paper, "Adapting Theory to Practice in Making High Strength Light Metal Sand Castings," will be authored by Prof. Howard F. Taylor and Dr. N. C. Flemings, Jr.,

Chapter Officers Conference in June Provides Chairmen an Opportunity to Discuss Problems

Chapter Chairman and Program Chairmen of the 47 AFS Chapters and AFS officials will participate in the 15th Annual Chapter Officers Conference to be held June 12-13 at the Hotel Sherman in Chicago.

The meeting is designed to acquaint chapter officers with the purposes and activities of the Society, to discuss mutual problems, and to prepare 1958-59 technical programs.

Chapter officials will receive assistance in improving chapter and regional meetings, maintaining and increasing membership, and how to initiate and develop educational programs.

Various phases of the Society's program will be explained by Head-

Massachusetts Institute of Technology, Cambridge, Mass.

Other American authors will also present technical papers at the 25th International Foundry Congress to be held in Belgium, Sept. 29-Oct. 3.

AFS Directors Elect May as Society's Treasurer

Edward R. May in January was elected AFS Treasurer by the Board of Directors. May joined the Society in 1952 as an accountant, served as assistant treasurer from July, 1956 until elected treasurer.

May was born in Chicago and was graduated from Fort High School,



Edward R. May

Fort Atkinson, Wis. in 1942. He then attended Business Institute of Milwaukee, Milwaukee, and in 1949 was graduated from Northwestern University, Evanston, Ill., with a degree in commerce. He graduated from Alexander Hamilton Institute, New York in 1952.

Prior to joining AFS, May was secretary-treasurer of George H. Elliott & Co., Chicago, for seven years.

quarters Staff and National Officers.

Among the topics to be discussed by AFS Staff personnel will be the Training & Research Institute program and its activities to date, the Safety, Hygiene and Air Pollution Control program. MODERN CASTINGS, technical activities, AFS publications, the 2d Engineered Castings Show to be held in Chicago April 13-17 at the Sherman Hotel, membership, and an explanation of Society policies and future plans.

The Conference Banquet will be held Thursday night, June, 12 with Dr. Dewey Annakin, Indiana State College, Terre Haute, Ind., discussing front line supervision and employee relations.

T&RI Opens Its Program of Chapter-Sponsored Courses

A successful, three-day intensive course, "Cupola Melting of Iron," held in Berkeley, Calif., Feb. 10-12, opened the Training & Research Institute's program of presenting courses in cooperation with AFS chapters.

Arrangements for the course, sponsored by the Northern California Chapter, were started after preliminary work began on a similar course held at Hamilton, Ontario, Canada, March 16-19.

"Much of the credit for the west coast course is due to the efforts of AFS Director John R. Russo," stated T&RI Director S. C. Massari. Russo's activities were largely in the Northern California Chapter area which produced the majority of the enrollment.



Howard H. Wilder, one of the instructors at the T&RI course presented at Berkeley, Calif.

Three teachers conducted the 3-day course which included lectures, question and answer periods, and a review of activities. The instructors were Howard H. Wilder, Vanadium Corp. of America, Chicago; T&RI Director S. C. Massari; and T&RI Training Supervisor R. E. Betterley.

Activities were opened Monday with a discussion of cupola design and construction, blowing equipment, and raw materials handling equipment. This was followed by a review of classification and purchasing of raw materials.

Registrants were provided with a booklet of scrap specifications reproduced from the *Institute of Scrap & Steel Yearbook*.

Classes continued after lunch with an analysis of coke covering such topics as sizing and handling, test-

ing, chemical composition, variations in behavior in cupola, charging, and effect of coke size on melting.



R. E. Betterley, T&RI Training Supervisor, discusses a point with two foundrymen attending courses. Shown on left is Terry Boscacci, American Brass & Iron Foundry, Oakland, Calif., and Art Brown, U.S. Pipe & Foundry Co., Decoto, Calif., appears on right.

Other subjects were the cupola bed, charge preparation and control of melting temperature and rate.

Tuesday morning's program covered desulfurizers, finishing the heat, slagging, operation problems, forehearth and ladles, and cupola lining.

In the afternoon metal temperature measurement equipment, metallurgy of cast iron, and metal control were analyzed.

The program was concluded Wednesday with combustion in the cupola, cupola records, an achievement test, and a course summary.

A survey of those attending shows that foremen and sales personnel represented the two largest groups attending. Others were metallurgists, chemists, superintendents, and plant executives.

The second of the chapter-sponsored T&RI courses was held March 17-18 at Hamilton, Ont., in cooperation with the Ontario Chapter.

AFS members from the Ontario, Eastern Canada, Rochester, and Western New York Chapters attended the cupola melting course.

Course Changes

■ The Sand Control & Technology Course, S23A-58, originally scheduled for Rackham Foundation, Detroit, Aug. 4-8, has been changed to Aug. 11-15.

■ The Metallography of Non-Ferrous Metals Course, MTY2A-58, originally scheduled June 25-27 in Chicago, has been changed to Sept. 15-17.

Courses to be Presented by T&RI During April

Course No.	Subject & Description	Course Length (Days)	Where Given	Course Fee
M2A-58	Melting of Copper Base Alloys April 2-4 Lecture course for melters, supervisors, metallurgists, and foremen. Nomenclature, alloy classification, melting technology, equipment, quality control, testing, and raw materials. Basic control variables are considered in light of optimum results with maximum safety to personnel and equipment.	3	Chicago	\$40
MTY1A-58	Metallography of Ferrous Metals April 16-18 Lecture and demonstration course for melters, supervisors, foremen, foundry engineers, researchers, laboratory technicians, metallurgists, and design engineers. History, basic metallurgy, terminology, equilibrium and phase diagrams, micro and macro analysis, physical properties based on metallographic interpretation, heat treatment, and graphic representation. Equipment and basic principles of metallography.	3	Chicago	\$40

Attendance limits will govern all sessions to insure personalized instruction, and in keeping with available facilities.

Registration by mail addressed to Director, AFS Training & Research Institute, is required. Acceptance will be made in order of applications received—payment of tuition fees must accompany registration application.



Organization for the first regional T&RI course presented with chapter sponsorship was largely in the hands of these men: S. C. Massari, T&RI Director; John R. Russo, AFS Regional Vice-President; and R. E. Betterley, T&RI Training Supervisor. — J. M. Snyder

Wisconsin Regional Speakers Predict Bright Future for Foundries in Competitive Market

Ways and means of meeting competitive methods of metal fabrication through superior castings produced at lower cost were outlined to 689 foundrymen at the 21st Wisconsin Annual Regional Foundry Conference sponsored by the AFS Wisconsin Chapter in cooperation with the University of Wisconsin.

The conference, held Feb. 13-14 at the Hotel Schroeder, Milwaukee, included 20 separate technical sessions and four general meetings on subjects of current interest.

Leslie J. Woehlke, Grede Foundries, Inc., Milwaukee, served as conference chairman. Co-chairmen were L. S. Krueger, Pelton Steel Casting Co., Milwaukee, and Prof. P. C. Rosenthal, University of Wisconsin, Madison, Wis. Wisconsin Chapter Chairman Norman N. Amrhein, Federal Malleable Co., Milwaukee, was conference president.

The program was opened Thursday morning with a welcoming address, "Planning for the Future," by Kurt F. Wendt, Dean, College of Engineering, University of Wisconsin, who said that universities should emphasize the basic subjects while industry must teach the particular arts to young men after their graduation.

AFS President Harry W. Dietert spoke on "The Man We Employ," tracing the advances of man through the adaptation of various power sources. He said that the learning capacity of man is dependent upon his rate of learning and rate of forgetting.

AFS Director Allen M. Slichter told foundrymen that opportunities are unlimited in the castings field. He outlined the role of AFS in stimulating and distributing information vital to the foundry industry. In his talk titled "Horizons Unlimited" the speaker said, "The three fundamental approaches needed to conduct an aggressive, industry-wide offensive are technical research, market research, and vocational and college education."

"Safety Aspects of New Foundry Processes," by Dr. Edward G. Meiter, director, Industrial Hygiene Div., Employers Mutuals of Wausau, Milwaukee, concluded the morning's program. Dr. Meiter dealt with the precautions to be followed in using various processes and raw materials.

Carl Taylor, president, Waukesha

State Bank, addressed the Thursday luncheon on the subject of "Political Business."

Thursday Afternoon

First Technical Sessions

Malleable—R. K. Daily, Lester B. Knight & Associates, Inc., Chicago, spoke on "Effective Profit Control," stating that "Perhaps the most vital loss which much of industry has suffered in the last ten-year period is cost consciousness."

He pointed up the advantages of epoxy resins and listed the versatility of epoxies as one of their outstanding advantages.

Thursday Afternoon

Second Technical Sessions

Malleable—V.A. Guebard, Jr., International Harvester Co., Milwaukee, spoke on "CO₂ Coremaking and Molding" and Prof. Carl E. Wulff, University of Wisconsin, discussed "Gassing of Sodium Silicate Cores."



Seated at the speakers table are AFS General Manager Wm. W. Maloney, AFS President Harry W. Dietert, AFS Director Allen M. Slichter, and Carl Taylor, Waukesha State Bank, who addressed the Thursday luncheon meeting. — Bob DeBroux

Non-Ferrous—A. Nichamin, Federated Metals Div., American Smelting & Refining Co., Detroit, predicted a bright outlook for the aluminum industry in his talk on "Good Aluminum Foundry Practice." He emphasized the necessity of maintaining accurate records on all production to insure continuous quality in castings.

Gray Iron—Mervin H. Horton, Deere & Co., Moline, Ill., in discussing "Water-Cooled Cupola Construction, Economics, Operation and Problems," pointed out pitfalls to avoid and the possible savings from the use of these cupolas.

Steel—Clarence Sims, Battelle Memorial Institute, Columbus, Ohio, in "Deoxidation of Steel Castings" stated that deoxidation was used primarily to produce sound castings with secondary considerations to reducing hot tears and other defects.

Pattern—Robert LeMasters, Nelson Pattern Co., Muskego, Wis., traced the history of plastics in the foundry in presenting "Advanced Plastics."

Non-Ferrous—Oscar Kraft, Westover Engineering, Inc., Milwaukee, in "Cost Problems in the Cleaning Room" suggested various methods of gate and riser removal, blast and grinding procedures and means of lowering costs. He stressed the importance of efficient cleaning room equipment layout to provide a proper flow of castings.

Gray Iron—Alexander D. Barczak, Superior Foundry, Inc., Cleveland, in "Molding—Nothing Has Been Changed," outlined molding procedures, tools, materials, and various processes. He emphasized that regardless of method employed it is necessary that the molder thoroughly understand essential details of his job.

Steel—George Witt, Foundry Service Engineers, Lombard, Ill., compared exothermic-lined risers and conventional risering in his talk on "Solidification of Cast Steels and Practical Application of Exothermic Materials." Photographs were shown illustrating the uses of liners in reducing the gross weight of castings.

Pattern—George Schuller, Caterpillar Tractor Co., Peoria, Ill., in "Pattern Engineering," recommended an exchange of ideas by all persons involved in the design or manufacture of castings as a means of producing well-designed castings. A mutual understanding of problems prior to design by all concerned will eliminate many difficulties encountered after the casting has been made.

Conference Banquet. Wisconsin Governor Vernon W. Thomson, explained to Wisconsin foundrymen the steps taken to attract industry into the state and to aid present Wisconsin industry. The governor also pointed out that Wisconsin is first in the nation in production of internal combustion engines, industrial controls, and malt beverages.

Friday Morning

Technical Sessions

Malleable—Fred Gunther, Belle City Malleable Iron Co., Racine, Wis., in "Foundry Maintenance," stated that



Governor Vernon W. Thomson, speaker at the Thursday evening banquet who spoke on "Wisconsin Faces the Challenge of the Future."

the importance of a sound maintenance program is growing with increased production and greater emphasis on quality control. He stressed the need of a record system which must be simple in nature and designed for each plant. Specific maintenance recommendations were made for various types of foundry equipment and machinery.

Non-Ferrous—William M. Ball, Jr., R. Lavin & Sons, Inc., Chicago, presented a talk on "How the Melting of Brasses and Bronzes Affect the Quality of Castings," citing specific problems and their solution.

Gray Iron—Dr. William L. Lea, Wisconsin Board of Health, presented an illustrated lecture on "Noise and Its Possible Effects in the Foundry," showing actual foundry installations and the amount of noise reduction effected through the installation of proper equipment.

Steel—"How Do You Handle Your Air-Arc Operation?" Lloyd Olson, Bucyrus-Erie Co., South Milwaukee, Wis.; Steve Kline, Crucible Steel Cast-



N. N. Amrhein, Wisconsin Chapter President and President of the Wisconsin Regional Foundry Conference Committee.

ing Co., Oconomowoc, Wis.; and Arthur Hare, Grede Foundries, Inc., Milwaukee, panelists.

The speakers detailed the use of the air-arc process in their specific foundries, describing its advantages but warning that it is not a cure-all for all metal removing problems. However the panelists cited the advantages of the process for various applications.

Pattern—James Venetucci, Liquid Carbonic Corp., Chicago, "Pattern Equipment for CO₂ Process," stated that the advantage of the process to perform a vital link in the foundry should be conceived at the design level.

He listed certain conditions advantageous to the CO₂ process which can be incorporated in the pattern equipment.

Luncheon—George Gilbert Groman, delivered a humorous talk on dialects in the United States.

Friday Afternoon

Technical Sessions

Malleable—Walter Scholtz, Allis-Chalmers Mfg. Co., Milwaukee, discussed "Safety and Industrial Health."

Non-Ferrous—Z. Madacey, Beardsley & Piper Div., Pettibone Mulliken Corp., Chicago, outlined the principles of "Coremaking & Core Blowing," stating that with the recent improvements in core blowers, the sands bonded with oil, dry binders, resins or silicates can be blown successfully into metal, plastic, or wood coreboxes with proper rigging of box and blow plate. The basic physical actions taking place in the blow cycle were explained as well as the proper venting of core boxes.

Gray Iron—John F. Wallace, Case Institute of Technology, Cleveland, explained the principles of "Gating of Gray Iron Castings," which included practical gating systems on actual castings and a discussion of gating into risers and optimum pouring times for large castings.

Wallace pointed out that the quality of gray iron castings can be improved by the utilization of engineered gating procedures. He discussed the application of a gating system to simple shapes and actual iron castings, the influence of gating into risers, and the effect of top risering and large castings.

Steel—Charles Christopher, Continental Div., Blaw-Knox Co., Munster, Ind., spoke on "Hot Tears—A Major Casting Defect," listing fluidity, design, temperature, sulphur, and collapsibility as factors contributing to hot tears. Correct heading and gating with temperature distribution were cited as means of reducing hot tearing.

Pattern—"Apprentice Program Forum," Erwin Czerwinski, Nelson Pattern Co., Milwaukee; Augie Komar, Spring City Pattern Works, Inc., Waukesha, Wis.; Leonard Licau, Allis-Chalmers Mfg. Co., Milwaukee; Carl Jurack, Charles Jurack Pattern Co., Milwaukee, panelists. The panel with Chairman A. F. Pfeiffer, Allis-Chalmers Mfg. Co., Milwaukee, outlined the apprentice training program supervised by the Wisconsin Industrial Relations Department.

Members explained the role of the Industrial Commission, the union, and the employer in the apprentice program.

■ Papers presented at the Wisconsin Regional Foundry Conference have been described briefly. More detailed abstracts of many of the papers will be presented in the future issues of MODERN CASTINGS.

Ways of Improving Foundry Instruction to be Discussed at Seminar June 19-21

■ Methods of improving foundry instruction in secondary and vocational schools will be discussed at the 3d Annual AFS Foundry Instructors Seminar to be held June 19-21 at Case Institute of Technology, Cleveland. The Seminar is sponsored by the AFS Education Division.

The seminars are designed to encourage closer relations between schools and the foundry industry by fostering advanced teaching facilities and incorporating the latest developments in foundry and patternmaking.

Invitations to attend are being issued by AFS to instructors in foundry and pattern shop courses in secondary and vocational schools as well as teacher-training institutions. AFS will assume all expenses of those attending except for transportation.

- by I. H. Dennen, Beardsley & Piper Div., Pettibone Mulliken Corp., Chicago.
- 3:30 pm "AFS Training & Research Institute," R. E. Betterley, T&RI Training Supervisor.
- 4:00 pm "How Industry is Using T&RI," Burton L. Bevis, Caterpillar Tractor Co., Peoria, Ill.
- 5:00 pm Panel discussion.
- 5:40 pm Workshop orientation.
- 6:00 pm Dinner, Case Institute.
- 7:00 pm Workshops, divided by class of schools.

FRIDAY, JUNE 20

- 9:00 am Workshop reports.
- 11:00 am "Cast Metals in the General Shop."



Tomlinson Hall, Case Institute of Technology, site of Seminar.

Program leaders have been selected from education and industry and the facilities of Case Institute will be available for classes and work shops. A field trip has been tentatively scheduled to provide instructors with an opportunity to observe actual foundry operations.

Instructors attending the Seminar will be housed at Case Institute. Technical sessions will be held in Tomlinson Hall.

The tentative program:

THURSDAY, JUNE 19

- 8:15 am Registration.
- 9:00 am Welcome and orientation.
- 9:15 am Board busses.
- 9:30 am Field trip
- 11:30 am Return to Case Institute.
- 12:00 Lunch, Case Institute.
- 1:00 pm Discussion of field trip.
- 2:00 pm "Scope of New Casting Developments," John Wallace, Professor of Metallurgical Engineering, Case Institute.
- 2:45 pm Training film, presented

- 12:00 Lunch, Case Institute
- 1:00 pm "Crucible Melting and Care."
- 1:45 pm "Controlling Casting Quality," Clyde A. Sanders, American Colloid Co., Chicago.
- 2:30 pm "Safety Practices for Foundries," H. J. Weber, AFS Director of Safety, Hygiene and Air Pollution.
- 3:30 pm "Visual Aids."
- 4:15 pm "AFS Chapters and How They Can Help," Wm. W. Maloney, AFS General Manager.
- 6:00 pm Dinner, Tudor Arms Hotel.

SATURDAY, JUNE 21

- 8:30 am Workshop instructions.
- 8:45 am Workshops.
- 10:45 am Workshop reports.
- 11:45 am "Shakeout."
- 12:30 pm Getaway Luncheon, Case Institute.
- 1:45 pm Evaluation meeting.

Southeastern Regional Places Emphasis on Latest Foundry Techniques and Processes

Continuous operation of the water-cooled cupolas for as long as one or two months without shutdown was predicted by M. J. Henley, vice-president, Tyler Pipe & Foundry Co., Tyler, Texas, in his talk presented at the 26th Annual Southeastern Regional Foundry Conference, Feb. 20-21, in Chattanooga, Tenn. The room was filled to overflowing with foundrymen anxious to hear about the outstanding success that Tyler Pipe has had over the past two years with their water-cooled cupola melting operation.

Henley described Tyler's experiences with continuous operation for as long as 15 days and intermittent operation with 8-hour bank-over periods for much longer periods of time. Since the cupola has no lining except carbon in the well, it can be operated acid, neutral, or basic with a metal charge consisting entirely of scrap.

Foundrymen present were further impressed by Henley's comments on the cleanliness and fluidity of the iron produced; the savings in metal, manganese, and refractories; and the exceptional ability of their cupola to produce ductile cast iron.

An air of congenial hospitality permeated the entire two days of technical sessions and social events. Conference Chairman Frank Anderson made everyone feel welcome, even the many Yankee visitors whom he chided about bringing their northern weather along with them. (Chattanooga broke an all-time record for snow and cold weather in the several days preceding the conference.) This was the second time that Chattanooga was the scene of the Southeast Regional, sponsored by the Tennessee, Birmingham District, and University of Alabama Chapters of AFS. Registered attendance exceeded 320 men, proving the excellent attraction power of the fine program arranged by Program Chairman Jack Austin.

Final details of arrangements were made on Wednesday evening at a special pre-conference dinner for speakers, special guests, and technical chairmen of each session. Luncheon on the first day of the conference found about 200 men of the castings industry on hand to be welcomed by Scott N. Brown, president of the Chattanooga Chamber of Commerce. AFS President Harry W. Dietert and Vice-President Lewis H. Durdin pre-



Presiding at the annual banquet was Southeastern Regional Conference Chairman G. Frank Anderson, Tennessee Products & Chemical Corp., Chattanooga, Tenn. Shown on the left are: Entertainment Chairman Herman Bohr, Jr., Robbins & Bohr, Chattanooga, Tenn.; Program Chairman W. L. Austin, U.S. Pipe & Foundry Co., Chattanooga, Tenn.; AFS President Harry W. Dietert, Harry W. Dietert Co., Detroit; and banquet speaker Leo Aikman. On the right are AFS Vice-President L. H. Durdin, Dixie Bronze Co., Birmingham, Ala.; and AFS Director Karl L. Landgrebe, Jr., Wheland Co., Chattanooga, Tenn.

sented talks on behalf of the Society. Two other national directors, Karl L. Landgrebe, Jr. and Herbert Heaton were on hand for the conference. Concurrent with this event was the ladies' luncheon held at the Fairland Club, Lookout Mountain.

National officers and ladies were honored Thursday evening at a reception and banquet. Digressing from the usual custom of having the celebrities make after-dinner talks, Herman Bohr, Jr., chairman of the event, called on the various wives of visiting officials to express their sentiments on the occasion—and they did a "beautiful" job.

The traditional annual banquet was fittingly held in the Tennessee room of the Patten Hotel on Friday evening. Leo Aikman, well-known writer, newspaper man, and humorist, wound up the occasion with an entertaining talk on the subject "Automation and You."

An outstanding program of plant visitations was scheduled for Friday morning. A series of shuttle buses made it convenient for visiting foundrymen to visit as many of the ten foundries as they wished, and to stay as long as convenient. Host foundries that conducted guided tours to their plants were: Strickland Pattern Works, Eureka Foundry Co., Combustion Engineering, Inc., Ross-Mehan Foundries, Moccasin Bushing Co., U. S. Pipe & Foundry Co., The Wheland Co., Crane Co., Chattanooga Aluminum Foundry, and Tennessee Products & Chemical Corp.

Outstanding from the standpoint of mass production and modern integrated methods were Combustion Engineering, Inc. and The Wheland Co.

The former demonstrated automated, centrifugal ramming of molds and centrifugal casting of soil pipe; while Wheland showed mass production of automotive brake drums and transmission cases utilizing diaphragm molding machines to make molds at the rate of one every 15 seconds per machine.

Probably no subject is of more interest to foundrymen these days than the "future of the foundry industry," which was the subject of a talk by F. G. Steinebach, vice-president and secretary of Penton Publishing Co.,

operating in this country.

The growing demands of local communities and labor unions are being felt in every foundry in this country. In many cases, foundrymen are having imposed upon them unfair regulations. A number of these were cited in a talk entitled, "Recent Important Legislation Affecting Foundries," by H. J. Weber, contributing editor to MODERN CASTINGS magazine. He warned foundrymen to be alert to their liabilities to community and employees, and to call on American Foundrymen's Society for assistance any time a local ordinance is being drawn up to affect their plant operations.

A novel, thought-provoking and stimulating discussion resulted from the talk given by T. E. Barlow, sales manager of Eastern Clay Products, Chicago, entitled "It Ain't Necessarily So." Mr. Barlow listed eight rules of green sand molding which are generally accepted as being proven practices. However, he was able to show exceptions to every one of these so-called hard and fast rules. By the time the speaker finished his talk everyone was thoroughly convinced that what he thought was so, really wasn't, after all.



AFS President Harry W. Dietert and AFS Vice-President L. H. Durdin shown with Southeastern Regional Conference Chairman G. Frank Anderson and Conference Finance Chairman Charles E. Seman.

Cleveland. The speaker reviewed the past history of the industry as an indication of what can be expected in the not too distant future. He traced the growth in annual tonnage of castings produced, the growth of technical and trade organizations in the castings industry, and the decreasing number of total foundries

J. G. Kura, chief of the metallurgy division, Battelle Memorial Institute, Columbus, Ohio, long associated with broad research programs on gating practices, presented an authoritative talk on "Effect of Gating Practice." All those in attendance were given three pages of instructive material to use as a guide for designing gat-

ing systems. Effective gating will reduce turbulence, dross formation, aspiration of gases into the metal, and mold erosion.

Forty years of service in the foundry industry provides a good background for giving advice to fellow metalcasting men. With this much experience behind him, Henry Marius, manager of Lenoir Car Works, Lenoir City, Tenn., talked about the "fundamentals of a successful foundry operation." The speaker attributed a lot of the troubles met with in the casting industry to poor understanding of the metallurgical fundamentals of metals; to physical tests which do not truly indicate the properties of the casting; to components designed by men with no understanding of the casting process; and to unrealistic applications of mechanization to foundry operations.



Foundrymen shown at the **Southeastern Regional** pre-convention dinner are: John Drenning, Kerchner Marshall & Co., Birmingham, Ala.; Porter Warner, Jr., Porter Warner Industries, Chattanooga, Tenn.; Wesley J. Estes, U.S. Pipe & Foundry Co., Birmingham, Ala.; AFS Vice-President L. H. Durdin; AFS President Harry W. Dietert; G. Frank Anderson, Tennessee Products & Chemical Corp., Chattanooga, Tenn.; W. L. Austin, U.S. Pipe & Foundry Co., Chattanooga, Tenn.; Sam F. Carter, Jr., American Cast Pipe Co., Birmingham, Ala.; AFS Director Karl Landgrebe; Jack H. Schaum, Editor, MODERN CASTINGS; M. D. Neptune, National Cast Iron Pipe Div., James B. Clow & Sons, Birmingham, Ala.; Jim Abe Jackson, Mexico Refractories Co., Chattanooga, Tenn.; and Aubrey M. Garrison, Jr., T. H. Benners Co., Birmingham, Ala.

"Major Aluminum Problems and Their Solution" is a subject which will always hold the attention of light metal foundrymen. The subject was ably handled by B. L. Meredith, of Federated Metals Div., American Smelting & Refining Co., South Plainfield, N. J.

The speaker reviewed all the precautions necessary to the proper melting of aluminum base alloys, including such things as temperature control, degassing with chlorine and nitrogen, and grain refining with titanium. Properly prepared metal must still enter the mold cavity through a gating system which guarantees cleanliness and elimination of turbulence. A review of the gating techniques developed at Battelle Memorial Institute showed how this could be accomplished.

W. A. Weaver, president of Modern Patterns & Plastics, Inc., Toledo, Ohio, packed the room with a subject which always gets attention these days—namely, "The Use of Plastics in the Pattern Shop." Through the use of a series of slides, the step by step construction of a plastic pattern

was clearly demonstrated. The speaker cautioned patternmakers to enter into the use of this new material on a conservative basis. Production experience with plastic patterns is proving their merit as a material superior to wood, and cheaper than metal. Metal fiber filled epoxy resins are showing encouraging promise as a material suitable for shell mold patterns.

Equal to the previous subject in its ability to attract foundrymen was a talk on "CO₂ Process and Coremaking." Leroy A. Bizzell, methods engineer, U. S. Pipe & Foundry Co., Chattanooga, Tenn. told the story of their company's experiences with the CO₂ process in a slide-illustrated talk. The speaker traced all the steps of producing large cores for 16-in. mechanical pipe joints. Collapsibility can be obtained by the addition of sugars,

syrups, sea coal, pitch, or cellulose. According to the speaker, U. S. Pipe is saving 30 cents per hundred lb of sand by using the CO₂ method, compared with the material costs used in their conventional coremaking.

A highly controversial subject, the new liquid limit test for bentonite, established by the Steel Founders' Society of America, was presented by a man who has probably done more work on this particular test than any other man in the industry, namely Victor E. Zang, vice-president, Unitcast Corp., Toledo, Ohio. His talk, "The Evaluation of Bentonites in the Steel Foundry," described all the details of the actual test. The speaker showed a comparison of tests conducted on different bentonite samples. These properties were correlated with a series of test-block castings made with various sand mixes. Unitcast Corp. is using the liquid-limit test for qualifying the acceptance of bentonite shipments. The net result has been receipt of more uniform bentonite.

■ More extensive reviews of most of these talks will appear in future issues of MODERN CASTINGS.

Northern California is Host to Regional Meeting



AFS chapter representatives of **Region No. 5** held their first annual meeting Feb. 8, at the Hotel Claremont, Berkeley, Calif. Discussions were conducted on mutual chapter problems and various activities to be held during 1958-59. Regional Vice-President John R. Russo presided. Seated left to right are: Leon Morel, Jr., and John W. Uren, Washington Chapter; Robert M. Burns and John F. Oettinger, Oregon Chapter; Regional Vice-President John R. Russo; S. C. Massari and Ralph E. Betterley, AFS Staff; Harry K. McAllister, Oregon Chapter; and E. C. J. Bird, British Columbia Chapter. Standing are: Otto H. Rosentreter, and E. G. Gaskell, Southern California Chapter; Harold E. Henderson, Gordon Martin, Davis Taylor, J. M. Snyder, Leonard E. Silvey, Raymond W. Haun, Donald C. Caudron, Byron F. McDonald, M. E. Ginty, and Earl Paetenghi, all of the Northern California Chapter. — J. M. Snyder.

Discussing the program at the meeting of chapter Officers for Region No. 5, seated: Oregon Chapter Chairman Harry K. McAllister, Western Foundry Co., Portland, Ore.; Southern California Chapter Vice-Chairman Otto H. Rosentreter, Otto H. Rosentreter Co., South Gate, Calif.; AFS Vice-President John R. Russo, Russo Foundry Equipment Co., Oakland, Calif. Standing are British Columbia Chapter Chairman E. C. J. Bird, Bird Aluminum Foundry, Ltd., Vancouver, British Columbia; and Northern California Chapter Vice-President Gordon L. Martin, Atlas Foundry & Mfg. Co., Richmond, Calif. Northern California Chapter acted as hosts to officials from Southern California, Oregon, Washington, and British Columbia Chapters.



Foundrymen Join New Group Devoted to Studying Problems of Air Pollution

■ Formation by the Air Pollution Control Association of a Committee on Foundries, headed by H. J. Weber, AFS Director of Safety, Hygiene and Air Pollution Control Program, gives foundrymen a more active participation in matters dealing with air pollution. Weber automatically becomes a member of the Technical Council of A.P.C.A.—an influential body where legislation is concerned.

The committee will have many of the same objectives as the SH&AP program of AFS. It will be responsible for the following:

- Establish definitions and nomenclature.
- Define the atmospheric pollution problems of the foundry industry.
- Seek a solution to these problems.
- Evaluate effectiveness of control equipment available and offered by manufacturers to do a particular job.
- Recommend practical limits of omissions.
- Develop recommended practices for equipment applications and operations to reduce air pollution to a minimum.

■ Recommend instruments and techniques for measuring emissions.

Some members of the A.P.C.A. committee are also members of the AFS committee on air pollution control. Committee members of the Committee on Foundries are:

Kenneth R. Daniel, American Cast Iron Pipe Co., Birmingham, Ala.

H. S. Faust, Hansell-Elcock Co., Chicago.

John M. Ford, Atlantic Steel Castings Co., Chester, Pa.

Floyd E. Frazier, National Association Mutual Casualty Companies, Chicago.

James W. Lake, Michigan Mutual Liability Co., Detroit.

John E. McIntyre, Sibley Machine & Foundry Corp., South Bend, Ind.

George L. Mitsch, A.C.F. Industries

Inc., St. Louis.

E. G. Meiter, Employers Mutuals of Wausau, Milwaukee.

Ray C. Ortgies, American Air Filter Co., Inc., Louisville, Ky.

Daniel R. Pohlman, Pohlman Foundry Co., Buffalo, N. Y.

Robert Pring, Wheelabrator Corp., Mishawaka, Ind.

Jack C. Radcliffe, Ford Motor Co., Dearborn, Mich.

W. O. Vedder, Pangborn Corp., Hagerstown, Md.

Herbert T. Walworth, Lumbermens Mutual Casualty Co., Chicago.

H. J. Weber, American Foundrymen's Society, Des Plaines, Ill.

M. F. Wendt, Arwood Precision Casting Corp., New York.

R. Grant Whitehead, Claude B. Schneible Co., Detroit.

Reminiscing by Former AFS President Points Up Progress Made by Foundries

■ E. H. Ballard, Swampscott, Mass., served as President of the American Foundrymen's Association 1931-32 and previously had been Vice-President and a Director. In 1948 he was awarded the AFS McFadden Gold Medal for personal contributions to the advancement of the castings industry.

Ballard retired in 1943 from his position of superintendent of foundries and pattern shops of the Everett and Lynn, Mass., plants of General Electric Co. In a recent letter to AFS Ballard commented on the changes which have taken place in the foundry industry since he started as a clerk in the 1890s.

"From 1897 to the present day it is impossible for me to visualize the great strides of the foundry industry, particularly in the production of steel castings. Before the days of the chemist and metallurgist, many problems were solved by cut and try methods. I sometimes wonder how so many foundries survived.

"Then, the exchange of information between foundries was hardly known. You had to steal into a plant like a thief in the night to obtain 'secret' data, or else hire someone from that plant to bring its practice with him. Compare this with the American Foundrymen's Society today.

"Through its broad policy of papers and information, it publishes a wealth of technical data for practically all branches of the industry. One has only to turn to the Society to find the answers to many perplexing

problems.

"I am particularly interested in 'The Foundrymen's Own Magazine' and note the great strides that have taken place even during the short space of 15 years. The January issue described a new line of aircraft and projectile castings of a complicated design, produced with limits never dreamed of only a few years ago.

"I often think what the Foundry-



E. H. Ballard

men's Society has done for the Castings Industry: Education in management, safety, sanitation, the formation of local chapters which has produced so many previously unknown men of outstanding qualifications, and now the Training and Research Institute, which again spells great promise for the Castings Industry. If the average foundryman could but know what hard work and discouraging experiences were once necessary to success, they would realize their lot today is much easier."

Committees in Action



Shell Molding Materials Testing Committee (Sand Division) met in Chicago during February. Shown left to right are: Alex Graham, Detroit; G. M. Etherington, American Brake Shoe Co., Mahwah, N. J.; R. J. Mulligan, Federal Foundry Supply Div., Archer-Daniels-Midland Co., Minneapolis; George I. Reynolds, Pennsylvania Glass Sand Co., New York; R. H. Jeeves, Durez Plastics & Chemicals, Inc., North Tonawanda, N.Y.; Nicholas Sheptak, Dow Chemical Co., Midland, Mich.; Jack E. Bolt, General Electric Co., Pittsfield, Mass.; John G. Smillie, John Deere & Co., Moline, Ill.; R. A. Rabe, General Motors Corp., Detroit; and Roderick J. Cowles, Walworth Co., South Boston, Mass.

Sand Division Bakeability Committee Makes Plans for Establishing Test for Commercial Core Oils

■ Steps were taken in January by the Bakeability Test Committee, Sand Division, to establish a procedure for the determination of relative bakeability of commercial core oils. Initially, the work will be confined to the use of core oils as binders.

Two tests will be employed. A tensile test and a chunk bakeability test. A hemispherical specimen will be used for the chunk bakeability test using four radii: 1 in.; 2 in.; 3 in.; and 4 in.

Tests will be based on baking temperatures of 350 F, 400 F, and 450 F, using six time intervals ranging from 30 min to 135 min.

Preliminary Test Schedule

The sand mixture will consist of Port Crescent Lake Sand (AFS Fineness 50-52), 1% oil, 1% cereal, and 2.5% water which will be added. The cereal is to be dried at 220 F, not less than two hours. Three oils and raw linseed oil will be employed. The sand is to be dried.

Mixing procedure.

- (1) Sand plus 1/3 of the water to be wet mulled for 30 seconds.
- (2) Cereal added and mulled for 1 minute.
- (3) Add balance of water and mull 3 minutes.
- (4) Add oil and mull 3 minutes.

It was suggested that after 1 minute of mulling and oil has been added, that the plows and wheels of the muller be scrapped down before mulling the final 2-minute period.

It was recommended that the oven be preheated to the specified temperature before inserting the specimens. A hardness test is to be made on the baked specimen surface, utilizing a commercial tester.

The committee noted that core oven atmospheres are extremely important and that the hot strength of a core is primarily a function of conditions under which it was baked rather than the oil used. Use of baking temperatures in production use to accelerate baking were not recommended because small cores, thin sections, or corners of heavy cores will be over-baked due to the high temperatures employed with resultant low strength.

Give Approval to Sections of AFS Radiation Manual

■ Approval was given to several sections of the RADIATION PROTECTION MANUAL at a January meeting of the Radiation Protection Manual Committee in Chicago.

The manual is being developed to promote safe practice for the use of x-rays, betatrons, and radio isotopes in foundries. It will include sections on Nature and Sources of Radiation in the Foundry, Health Aspects of Radiation, Control of Radiation in the Foundry, Radiation Detection Instrumentation, Protection by Shielding and Distance, Procedures for Handling and Use of Sources of Radiation, Training of Personnel, and Glossary.



Details on participation of the Sand Division in the 62d Castings Congress were discussed at the February meeting of the **Sand Division Program and Papers Committee** held in Chicago. The tentative program calls for activities during each day of the Congress to be held May 19-23. Due to the numbers of papers available for presentation an additional technical session has been requested. Shown left to right are: J. B. Caine, consultant, Cincinnati; Elmer C. Zirzow, Werner G. Smith, Inc., Cleveland; Louis J. Pedicini, Birmingham, Mich.; Robert H. Jacoby, St. Louis Coke & Foundry Supply Co., St. Louis; Victor M. Rowell, Harry W. Dietert Co., Detroit; Jack H. Schaum, Editor, MODERN CASTINGS, AFS representative.

Education Group Preparing Book for Foundry Teachers

■ As part of the overall AFS education program to strengthen relations between education and industry, preparation has been started by the AFS Education Committee on A GUIDE FOR SECONDARY SCHOOL CAST METALS INSTRUCTION.

The book will supplement the annual Foundry Instructors Seminar which fosters modern methods of foundry and pattern shop instruction and emphasizes the needs of the castings industry for personnel of specialized training.

Eleven chapters have been suggested including historical aspects, safety, making the castings, field trips, teaching aids, equipment and supplies, patterns and layouts, and reference texts.

The book will be illustrated with drawings, floor plans, layouts, job sheets, and operations sheets.

SH&AP Makes Revision in Status of Sub-Committees

■ Modifications in the status of sub-committees of the Safety, Hygiene and Air Pollution Control Steering Committee were made at a January meeting held in Chicago.

The Welding Committee and the Safety Committee have assumed a standby basis. Both the Air Pollution Control Committee and the Dust Control and Ventilation Committee will continue active during 1958-59 and then be available on a standby basis. The Noise Control Committee and the Radiation Protection Committee

will continue on an active basis indefinitely.

Wm. W. Maloney, AFS General Manager, outlined the relationship of the SH&AP program and the Training & Research Institute. He pointed out that an *Industrial Environment* and an *Air Pollution Control and Legislations* course will be offered by the Institute during 1958. It was suggested that SH&AP supply instructors for these courses.

Clay Determination Tests Produce Varying Results

■ Investigations conducted by the Grading, Fineness & Distribution Committee indicate a wide divergence in sand testing results when the clay is determined by the AFS standard method and much more consistent results when the sample is boiled.

The AFS standard clay determination appears best suited for sands containing small amounts of clay. A test using a 20-minute boil and 25 cc sodium hydroxide is preferable for sands containing pitch or resins. A 20-minute boil with 100 cc of sodium hydroxide is best for sands not containing pitch.

Further tests will be conducted by the committee utilizing a procedure outlined in the March, 1955 issue of AMERICAN FOUNDRYMAN. It was decided that the sample should be ignited to eliminate combustibles and boiled for 20 minutes. A second group is to be run using the AFS standard procedure. Three variations are to be tested—stirring for 5, 10, and 15 minutes—and recording the number of washings required to clear the sample of clay. 25 cc of 1/10 NaOH solution will be added.

Chapter News

Northeastern Ohio Conducts Two February Programs

■ Two events were held in February: the Second Annual Ladies Night party at the Tudor Arms Hotel, Cleveland, attended by 150 persons; and the monthly technical session featuring a talk on "Metal Corebox Equipment" by Walter E. Mason, Westinghouse Air Brake Co., Wilmerding, Pa.

Mason stated that metal pattern equipment is usually employed to increase production and reduce cost through use of equipment on molding machines and core blowers. This equipment has had increased usage due to higher labor costs and stricter customer specifications.

Accurate records must be main-

tained on each phase of production; proper scheduling and coordination of work during construction of pattern equipment is essential. Every pattern and corebox comprising a set of equipment should get full attention to detail.

Mason also discussed blow-in drier equipment. The top half of the box is mounted on a machine blowhead and only the drier is handled in and out of the machine. Production of cores is increased due to the time saved by handling.

A film was also shown describing the growing preparation, and use of mahogany in industry.—Robert H. Herrmann.



More than 150 persons attended the annual Northeastern Ohio Ladies Night.



Ladies Night program included dinner, floor show, and dancing.



Participating in technical session were technical chairman John F. Roth, Cleveland Standard Pattern Works; speaker W. E. Mason; and Walter H. Siebert, co-chairman Cleveland Standard Pattern Works.



St. Louis Chapter's February meeting featured a talk on "Shell Molding in a Production Jobbing Foundry," by John R. Nieman, Shell Process, Inc., Park Forest, Ill. Shown with castings and shell molds are Technical Chairman Jack H. Thompson, Bodine Pattern & Foundry Co., St. Louis; speaker Nieman; and Chapter Chairman James A. Cannon, Duncan Foundry & Machine Works, Inc., Alton, Ill.—H. V. Boemer

Ontario Chapter

Automatic Sand Control

■ More than 170 members attended the January meeting to hear Victor Rowell, Harry W. Dietert Co., Detroit, speak on "Automatic Sand Control."

Because of the more exacting demands of buyers with regard to surface finish and closer dimensional tolerances in castings, foundrymen must maintain closer control over the consistency of sand properties. Uniformity is also necessary for the efficient operation of automatic molding machines and core blowers.

Rowell outlined how uniformity may be controlled through an automatic system. The components of this system are an automatic muller cycle control with a programming timer, cam-operated valves, and automatic distribution to molding hoppers.—A. L. Cooper



Central Indiana

Features Six Speakers

■ Central Indiana's February meeting featured six speakers. John M. Thomas, Sonith Industries, Indianapolis, discussed operations of his company.

Robert M. Milhouse, Marion Malleable Iron Works, Marion, Ind., spoke on "Split Electric Furnace Annealing of Malleable and Pearlitic Castings." Bernard J. Lavelle, Lavelle Foundries, Anderson, Ind., outlined "Diversification of Metals" and Robert Figg, American Foundry Co., Indianapolis, presented "An Introduction to American Foundry."

Two other speakers completed the program. Eugene X. Wiley, Atlas Foundry, Marion, Ind., explained "The Trials and Tribulations in Starting a New Pallet Line Molding System," and Robert Langsenkamp, Langsenkamp-Wheeler Brass Co., Indianapolis, talked on "Air Pollution in a Brass Foundry."—William R. Patrick



John M. Thomas, one of six speakers at the Central Indiana February meeting.



Eastern Canada members at the February meeting heard F. W. Kellam, Electro Metallurgical Co., Div. of Carbide Canada, Ltd., Welland Ont., discuss "Alloying of Iron & Steel." Shown in photo, left to right: A. Lalonde, Montreal Foundry, Ltd., Montreal, Que.; A. K. Durrell, Dominion Engineering Works, Ltd., Montreal, Que.; James H. Newman, Newman Foundry Supply, Ltd., St. Lambert, Que.; Leon Gadoury, Crane, Ltd., Montreal, Que.; W. P. Sullivan, Warden King, Ltd., Montreal, Que.; C. R. Dutton, Crane, Ltd., Montreal, Que.; Willett Tibbitts, Canadian Steel Foundries (1956), Ltd., Montreal, Que.; Alex Pirrie, Standard Sanitary Products, Ltd., Toronto, Ont.; speaker Kellam; Max Reading, Foundry Services (Canada), Ltd., Beaurepaire, Que.; Joseph Strachan, Western Pattern Works, Ltd., Montreal, Que.; and J. H. Roberts, Canada Iron Foundries, Ltd., Trois-Rivieres, Que.—F. Machin

Chicago Chapter

Conducts Four Sessions

■ Four sessions were conducted at the Chicago Chapter February meeting. Clyde A. Sanders, American Colloid Co., Chicago, presented "Molding Methods Compared" to the non-ferrous and gray iron groups; R. W. Heine, University of Wisconsin, Madison, Wis., spoke to malleable foundrymen on the subject of "Controlling Malleable Iron Scrap." Francis H. Hohn, Scullin Steel Co., St. Louis, talked on "Vacuum Melting" at the steel and maintenance section. Harry Weaver, Brillion Iron Works, Brillion, Wis., outlined "Patterns for Shell Molding" at a pattern session.—Ed Burch



Speakers at Chicago's February meeting included Fred Landman, Brillion Iron Works, Brillion, Wis.; Harry Weaver; Clyde Sanders; Chicago Chairman William O. McFetridge; R. W. Heine; and Francis H. Hohn.



Discussing ways of improving casting quality at the Tri State January meeting are W. A. Hambley, Milwaukee, the evening's speaker, and Frank Skaggs, Oklahoma Steel Castings Co., Chapter Chairman.

Tri State Chapter

Puts Emphasis on Castings

■ Castings were discussed at the January and February meetings held in Tulsa, Okla. In January, W. A. Hambley, Chas. A. Krause Milling Co., Milwaukee, spoke on "Casting Defects."

In February, Clyde A. Sanders,

American Colloid Co., Chicago, discussed "Casting Finish, Tolerance, and Precision." In addition Sanders reviewed his recent tour of European foundries.

Apprentice night was also held at the February meeting with 12 apprentices attending.—Leslie O'Brien



New England Chapter members at the January meeting held in Boston, heard two discussions on the CO₂ process. Robert Anderson, Draper Corp., Hopedale, Mass., spoke on "CO₂ Cores for Cast Iron," and Frank Tibbitts, Wollaston Brass & Aluminum Foundry Co., Hingham, Mass., presented "General Discussion on CO₂." Photo shows Chapter Chairman Alexander Beck flanked by speakers Tibbitts and Anderson.—F. S. Holway and J. H. Orrok

Study Snagging Problems at Central New York

■ Savings to be realized in foundries through proper use of snagging and cutoff equipment and techniques were presented at the February meeting by John A. Mueller, Carborundum Co., Niagara Falls, N. Y.

Grinding wheel speed was listed as the most important single factor in efficient snagging operations. As wheel is reduced in diameter its cutting efficiency decreases if the wheel rpm remains constant. As a wheel wears it is necessary to increase the speed in order to maintain a constant surface speed.

Maintaining correct wheel speed will produce maximum results with minimum operational costs, Mueller stated.

Considerable discussion in the question and answer period was devoted to problems of maintaining a constant speed. Many foundrymen were of the opinion that the existing equipment

in small and medium foundries does not lend itself toward maintaining a constant speed.—C. W. Diehl



Technical chairman R. J. Denton, left, snags speaker Mueller who outlined correct snagging procedures to foundrymen.



Central New York members hearing John A. Muller's talk include this table of Frank Sarnuto, Peter Lampreda, William LaPorte, Charles Miester, Kenneth Gallien, Donald Brainard, Nicholas Pollastro, and Carl Diehl.



Shown at the Central New York February meeting are Robert Watson, Robert Renders, Joseph Otvus, Robert Markell, and Dominick Fantacone.

Northern California

Shell Molding Talks

■ Two speakers at the February meeting addressed the chapter on shell molding. An overflow crowd heard James L. Francis, Micro Metals, Inc., Oakland, Calif., discuss the ad-

vantages of the process and also viewed a variety of shell cores, molds, and intricate castings.

Herbert Von Wolff, Shalco Corp., Palo Alto, Calif., presented an illustrated talk on the variety and use of shell cores throughout the country.—Harold Henderson



Detroit Chapter's January meeting was attended by 150 members and guests. E. H. King, Hill & Griffith Co., Cincinnati, spoke on "Fundamentals in Molding Methods" and "Use and Preparation of Molding Sand." King's talk covered sand control, molding machine applications, and improved green sand practice. Shown left to right are speaker King; Chapter Chairman C. W. Yaw, Sr., Cadillac Motor Car Div., GMC, Detroit; and Program Chairman Victor Rowell, Harry W. Dieterl Co., Detroit.—Edwin A. Swenson

British Columbia Chapter

Holds Educational Meeting

■ Chapter members in February attended an educational meeting held at the Vancouver Vocational Institute. Prof. William M. Anderson, University of British Columbia, spoke on testing and inspection. Later the group met at Coast Testing Laboratories Ltd., where demonstrations were conducted on destructive and non-destructive testing.—J. T. Hornby.

Chesapeake Chapter

Making Foundry Coke

■ The history and manufacturing of coke was explained at the January meeting by Forrest Miller, Philadelphia Coke Co. The illustrated talk included colored photomicrographs of coal and a sequence on operations conducted in coke ovens. Views were also shown of other steps in the preparation, making, and handling of coke.

Two films were shown on chaplets and chills, demonstrating their manufacture and use.—Lewis H. Gross



Participating in the Chesapeake January meeting were Publicity Chairman L. H. Gross, American Radiator & Standard Sanitary Corp., Baltimore, Md.; speaker Forrest Miller; and Chapter Chairman Donald A. Roemer, Franklin-Balmer Corp., Baltimore, Md.—E. C. Klank



Toledo Chapter members at the February meeting heard R. T. Lewis, Keen Foundry Co., Griffith, Ind., discuss "Are Your Costs Reliable?" C. E. Eggenschwiler, Bunting Brass & Bronze Co., Toledo, Ohio, served as technical chairman.—C. M. Hannaford

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chapter meetings

APRIL	S	M	T	W	T	F	S
1	2	3	4	5	6	7	8
9	10	11	12	13	14	15	16
17	18	19	20	21	22	23	24
25	26	27	28	29	30		

APRIL

Birmingham District . . April 11 . . Country Club, Anniston, Ala. . . H. H. Wilder, Vanadium Corp. of America, "Cupola Operations."

British Columbia . . April 18 . . Pacific Athletic Club, Vancouver, B. C. . . J. E. Wilson, Climax Molybdenum Co., "Factors Affecting the Behavior of Steel Castings."

Canton District . . April 3 . . Elks Club, Alliance, Ohio . . H. A. Stuhldreher, U. S. Steel Corp., National Officers' Night.

Central Illinois . . April 7 . . American Legion Hall, Peoria, Ill. . . E. F. Price, Dayton Malleable Iron Co., "Finishing of Castings & Cleaning Problems." Question Panel: O. Lanier, Duncan Foundry & Machine Works & C. Duckler, Superior Foundry Co.

Central Indiana . . April 7 . . Athenaeum, Indianapolis . . R. C. Frank, Superior Steel & Malleable Castings Co., "The Big Difference."

Central Michigan . . April 16 . . Hart Hotel, Battle Creek, Mich.

Central New York . . April 11 . . Statler Inn, Ithaca, N. Y. . . C. A. Sanders, American Colloid Co., "Ithaca Sand."

Central Ohio . . April 14 . . Seneca Hotel, Columbus, Ohio . . Apprentice and Education Night.

Chesapeake . . April 25 . . Engineers' Club, Baltimore, Md. . . "Castings Clinic."

Chicago . . April 7 . . Chicago Bar Association, Chicago . . Gray Iron & Malleable Group: W. D. McMillan, Interna-

Chapter News

tional Harvester Co., "Water-Cooled Cupola Operation"; Steel Group: R. Ames, U. S. Steel Corp. South Works, "Refractories & Ladle Practice"; Maintenance Group: E. W. Greenlees, Kensington Steel Co., "Aches & Pains of Foundry Maintenance"; Non-ferrous & Pattern Group: M. Glassenberg, Armour Research Foundation, "Eliminating Leakage in Navy 'G' Pressure Castings."

Cincinnati District . . April 14 . . Alm's Hotel, Cincinnati . . M. K. Young, U. S. Gypsum Co., "Epoxy Resin Patterns for the Foundry Industry."

Connecticut . . April 23 . . Shuffle Meadows Country Club, New Britain, Conn. . . C. V. Nass, Beardsley & Piper Div., Pettibone Mulliken Corp., "Mechanization in the Small Foundry."

Corn Belt . . April 11 . . Lincoln, Neb., W. L. Adams, Eastern Clay Products Dept., International Minerals & Chemicals Corp., "Green Sand Molding."

Detroit . . April 17 . . United States Rubber Co., Detroit . . Plant Visitation.

Eastern Canada . . April 11 . . Sheraton-Mt. Royal Hotel, Montreal, Que. . . H. A. Burton, Canadian Steel Foundries, Ltd., "Review of Use of Reinforced Resins."

Eastern New York . . April 15 . . Panetta's Restaurant, Menands, N.Y.

Metropolitan . . April 7 . . Essex House, Newark, N. J. . . O. J. Myers, Reichhold Chemicals, Inc., "Sand Processes."

Mexico . . No Information Available.

Michiana . . April 14 . . Club Normandy, Mishawaka, Ind. . . C. A. Koerner, Central Foundry Div., GMC, "New Foundry Testing Methods."

Mid-South . . April 11 . . Hotel Claridge, Memphis, Tenn. . . Casting Clinic.

Mo-Kan . . April 4 . . Fairfax Airport, Kansas City, Kans. . . R. Cochran, R. Lavin & Sons, Inc., "Pouring Good Brass Castings."

New England . . April 9 . . Prof. M. Cohen, Massachusetts Institute of Technology, Cambridge, Mass., Tech Night.

Northeastern Ohio . . April 10 . . Tudor Arms Hotel, Cleveland . . E. A. Walcher, Jr., American Steel Foundries, "Building a Modern Foundry Organization."

Northern California . . April 14 . . Spenger's, Berkeley, Calif. . . A. Castignola, G. Wetstein, and M. Thomas, "Plastic, Plaster Cast & Shell Patterns."

Northern Illinois & Southern Wisconsin . . April 8 . . Lafayette Hotel, Rockford, Ill.

Northwestern Pennsylvania . . April 28 . . Arlington Hotel, Oil City, Pa. . . C. A. Sanders, American Colloid Co., "It's Not All Sand."

Ontario . . April 25 . . Seaway Hotel, Toronto, Ont. . . Annual Ladies' Night.

Oregon . . April 16 . . Heathman Hotel, Portland, Ore. . . J. E. Wilson, Climax Molybdenum Co., "Factors Affecting Behavior of Steel Castings."

Philadelphia . . April 11 . . Engineers' Club, Philadelphia . . Round Table; Non-ferrous: J. D. Allen, Jr., Federated Metals Div., American Smelting & Refining Co.; Cast Iron: J. S. Vanick, International Nickel Co.; Steel: J. Juppenlatz, Quaker Alloy Casting Co., "New Developments in Cast Metals."

Piedmont . . No Meeting.

Pittsburgh . . April 21 . . Hotel Webster Hall, Pittsburgh, Pa. . . T. W. Curry, Lynchburg Foundry Co., "Ductile Iron."

Quad City . . April 21 . . Hotel Ft. Armstrong, Rock Island, Ill. . . R. Andrews, Demmler Mfg. Co., "Blown Shell Molding—Evaluation & Exploitation."

Rochester . . April 1 . . Hotel Seneca, Rochester, N. Y. . . L. G. Burwinkel, Jr., Pennsylvania Glass Sand Corp., "Occurrence, Production & Uses of Quality Silica."

Saginaw Valley . . April 3 . . Fischer's Hotel, Frankenmuth, Mich. . . H. A. Wichert, Personnel & Business Consultant, "Humanics."

St. Louis . . April 10 . . Edmond's Restaurant, St. Louis . . L. D. Pridmore, International Molding Machine Co., "Core & Mold Blowing."

Southern California . . April 11 . . Rodger Young Auditorium, Los Angeles, Professor W. A. Snyder, University of Washington, "Olivine Sand."

Tennessee . . April 25 . . Patten Hotel, Chattanooga, Tenn. . . C. C. Sigerfoos, Michigan State University, "Opportunities in the Foundry Industry."

Texas . . April 18 . . Angelina Hotel, Lufkin, Texas . . Casting Clinic.

Texas, East Texas Section . . April 18 . . Joint Meeting with Texas Chapter.

Texas, San Antonio Section . . April 21 . . Kincaid-Osburn Electric Steel Co., San Antonio, Texas . . Plant Visitation.

Timberline . . April 11 . . Oxford Hotel, Denver, Colo. . . W. L. Adams, Eastern Clay Products Dept., International Minerals & Chemicals Corp., "Green Sand Molding."

Toledo . . April 2 . . Heather Downs Country Club, Toledo, Ohio . . W. G. Ferrell, Auto Specialties Mfg. Co., "How Health & Hygiene Affect Foundry Cost."

Tri-State . . April 18 . . Western Village Motel, Tulsa, Okla. . . Round Table Discussion.


Twin City . . April 8 . . Jax Restaurant, Minneapolis . . V. M. Rowell, Harry W. Dietert Co., "Synthetic Sand Practice."

Utah . . No Meeting.

Washington . . April 17 . . Engineers' Club, Seattle . . J. E. Wilson, Climax Molybdenum Co., "Factors Affecting the Behavior of Steel Castings."

Frank BUTOLD

General Manager
of the FOUNDRY
DIVISION
FORD MOTOR CO.



WORKED HIS WAY UP FROM CONTROLLER

HE WAS FEATURED SPEAKER
AT FOUNDRY EQUIPMENT
MANUFACTURERS' ASSN.
IN 1955

HE'S PRESIDENT
OF THE
FOUNDRY
EDUCATIONAL
FOUNDATION

Frank's Hobby
is Power Boating

Personalities

Western Michigan . . April 7 . . Finger's Restaurant, Grand Rapids, Mich. . . Non-ferrous—W. Gluntz, "How to Effect Economics on Reduced Operation." Ferrous—E. Hinze, "Monthly Cost Reduction Program."

Western New York . . April 12 . . Buffalo, Annual Spring Dance.

Wisconsin . . April 11 . . Schroeder Hotel, Milwaukee . . Senator Karl E. Mundt, (South Dakota). Management Night Speaker.

MAY

Birmingham District . . May 8 . . Thomas Jefferson Hotel, Birmingham, Ala. . . Panel Discussions: Maintenance, Molding.

Central Illinois . . May 5 . . Vonachen's Junction, Route 88 . . Panel Discussion: Molding, Melting, Cleaning and Core-making.

Central Indiana . . May 5 . . Athenaeum Turners, Indianapolis . . A. E. James,

Haynes Stellite Co., Union Carbide Corp., "Standardization & Compliance Programs in the Foundry."

Chicago . . May 5 . . Chicago Bar Association, Chicago . . L. B. Knight, Lester B. Knight & Associates, Inc., "Automation in the Foundry."

Northeastern Ohio . . May 8 . . Tudor Arms Hotel, Cleveland . . Recognition Night.

Piedmont . . May 2 . . Hotel Cleveland, Spartanburg, S.C. . . J. S. Schumacher, Hill & Griffith Co.

Rochester . . May 6 . . Hotel Seneca, Rochester, N.Y. . . Election of Officers.

Saginaw Valley . . May 1 . . Fischer's Hotel, Frankenmuth, Mich. . . R. W. Gardner, Dearborn Iron Foundry, Ford Motor Co., "Quality Control in the Foundry."

St. Louis District . . May 8 . . Edmond's Restaurant, St. Louis . . W. G. Gude, Foundry, "The Future of the Foundry."

Equipment Manufacturers Reply to the Question:

DOES FOUNDRY EQUIPMENT MEET FOUNDRY NEEDS?

In the February issue of **MODERN CASTINGS** foundrymen from all over the United States gave their answer to this question. A detailed discussion of the subject was covered by a feature article based on a talk presented at the 39th Annual Meeting of the Foundry Equipment Manufacturers' Association by Frank Shipley, Foundry Manager, Caterpillar Tractor Co., Peoria, Ill.



In order to present a complete picture of this problem to its readers, **MODERN CASTINGS** contacted 35 prominent foundry equipment manufacturers for their opinion. Some of the questions were:

What are you doing or planning to do in the near future with foundry equipment?

What can the foundryman do to help redesign equipment to meet his needs?

What can be done to minimize lost time due to breakdowns?

Here are a few of the remarks received from the manufacturers:

"As equipment manufacturers, it hurts us to see the way our equipment is improperly operated and improperly maintained in many foundries. Operating and maintenance manuals should be in the hands of the people who are responsible for the operation of foundry machinery and not in the purchasing department files. They should also be read."

"With today's automated machinery, some equipment manufacturers are giving serious consideration to adopting an over-all maintenance supervisory or insurance program on a monthly or yearly retainer fee to cope with problem of keeping machinery operating efficiently."

"There is a tendency on the part of all foundry purchasers to compare only surface specifications, ignoring the advantages of rugged construction, full safety guards, carefully engineered and furnished exhaust systems and easy, safe access to maintenance points."

"Maintenance of a stock of the proper repair parts by a foundry will solve many of their repair problems. The equipment manufacturers will cooperate in assisting the foundry to determine just what parts should be stocked by the foundry maintenance department."

"Equipment is often unnecessarily expensive because many foundries want machinery custom designed and built to suit the particular needs of their operation instead of adapting to standard models."

"Our company has a unit which is guaranteed against loss of production due to mechanical breakdown. Units all over the country have been operating a total of 600,000 hours without a single breakdown that stopped production."

"Most manufacturers of equipment supplying the foundry industry spend a considerable amount of money annually on development and research. Developments can proceed only as fast as the manufacturer can afford to spend the required money, and as fast as the industry can afford to purchase."

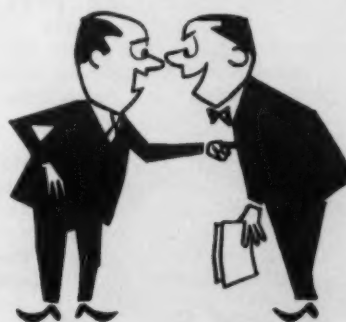
"One of the things which seems

to have been overlooked is the fact that the equipment manufacturer is now required to furnish much heavier, more rugged and closer tolerance equipment."

"Are the foundrymen going to pay the price for better equipment and services to gain longer life, higher efficiency and less maintenance? Someone has to."

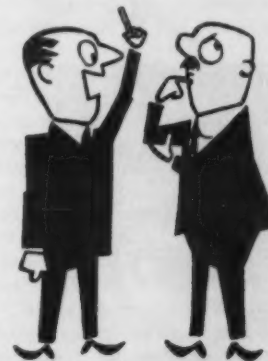
"Equipment manufacturers should not be expected to keep patterns for periods as long as 20 years in order to provide repair parts for obsolete machinery. The cost of proper storage space for patterns is high, and some parts for older machines may not be required more than once a year."

"We have for many years and are continuing to build heavily constructed, rugged equipment for foundry applications. It is guaranteed for five years when properly operated and maintained."



"Foundrymen are rightfully asking for more automatic features on their foundry machinery to shorten operating cycles, speed production and reduce costs. But it must be recognized that this requires better trained technicians, maintenance men, and supervision in the foundry to gain the advantages of proper operation, proper application and trouble-free operation."

"Any foundryman should be aware that maintenance is a necessary item and provision should be made on their part from the manufacturer's list of recommended parts to have these parts in stock. Other critical parts are generally kept in stock by reputable manufacturers and with any reasonable amount of warning can be furnished immediately."



"The erratic buying habits of the foundry industry as a whole make it very difficult for foundry equipment manufacturers selling only to the foundry industry to maintain adequate staffs over the long pull for as thorough a development for the foundries as they may desire."

"As long as the majority of our foundries are going to delay taking corrective steps to minimize public nuisance problems from their operation until legislation forces them to take such measures, there remains little or no incentive for the equipment manufacturer to divert full-time efforts on discovering the most economical solution to the problems."

If foundries are to attract the increasing numbers of better-grade personnel required for the casting industry to improve its position in the economy, it is going to be necessary to re-emphasize improved in-plant environment and public relations with the foundry neighborhood.

"There is an economic limit as to how much free engineering, operating service and maintenance help equipment manufacturer can give."

"As far as research and development goes, the cost has to eventually be carried in the sale price of equipment on any successful process or method of manufacture."

foundry trade news

Non-Ferrous Founders' Society . . . discussed the future for non-ferrous metals in aircraft and missiles production in its West Coast Management and Operating Conference held in Los Angeles in February. A panel, composed of J. J. Stobie, Apex Smelting Co., Long Beach, Calif.; Frank Warga, AiResearch Mfg. Co., Los Angeles; and Roger Cron, Los Angeles Div., North American Aviation; pointed out the opportunity for foundries which the demand for high quality aircraft and missile castings offers. Foundrymen were cautioned, however, that in order to retain the industry's share of future business, they must meet the challenge of higher specifications and more efficient foundry practice. Cron stated that even the most modern alloys such as the new Tens-50, "can be fouled up with excess impurities, gassed, drossed, and allowed to shrink with poor practice." The conference was hosted by the Southern California chapter with prominent foundrymen from all over the nation participating.

Lehigh Valley Foundrymen's Assoc. . . . featured R. J. Franck, Superior Steel & Malleable Castings Co., Benton Harbor, Mich., speaking at the February meeting. Lafayette College, Easton, Pa. Franck spoke on, "Proper Casting Through Experimental Stress Analysis," discussing all phases of planning from preliminary design to the finished steel castings. Extensive laboratory and field testing methods were described. A color film, "The Big Difference," supplemented the talk; it depicted development and testing of various castings. Chairman Albert Mathieu, Ingersoll-Rand Co., Phillipsburg, N. J., conducted the business meeting, and H. W. Streeter, Lehigh Foundries, Easton, Pa., served as technical chairman. The Association will meet again, April 8, 1958, at Lafayette College.

Malleable Founders' Society . . . held its Technical And Operating Conference in February at Cleveland. The program agenda was designed for the

interchange of information and experience on day-to-day production problems and also to provide information on new and future developments within the industry.

The two-day meeting included eight sessions; "Malleable Finishing Practice," "Industrial Engineering," "Malleable Engineering for the Operating Man," "Malleable Founders' Sponsored Research," "Molding Sand Fundamentals and Use," "Factors Affecting Malleable Casting Application," "Malleable Base Spheroidal Graphite Iron," and "Making the Malleable Foundry a Better Place in which to Work."

Gordon B. Mannweiler, Eastern Malleable Iron Co., Naugatuck, Ohio, served as chairman of the conference.

The Society has announced the 1957 winners of the yearly "Safety Self-Improvement Contest." They are: New Haven Malleable Iron Co., New Haven, Conn.; Superior Steel & Malleable Castings Co., Benton Harbor, Mich.; Wilmington Malleable Iron Works, Eastern Malleable Iron Co., Wilmington, Del.; and Texas Foundries, Inc., Lufkin, Texas.

The Society will hold its 9th Market Development Conference, April 9-10, at the Edgewater Beach Hotel, Chicago.

Central Foundry Div., General Motors Corp. . . . headquartered in Saginaw, Mich., recently inaugurated a series of one-day casting design conferences with the Saginaw; Defiance, Ohio; and Danville, Ill. plants



of the division serving as hosts to officials and engineers from customers of the plants. The first of the confer-

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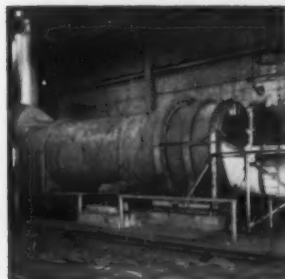
system—Link-Belt will furnish and install equipment that results in more efficient operation, lower costs and better working conditions.

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SEE OUR EXHIBIT, A.F.S. FOUNDRY SHOW,

Circle No. 748, page 7-8

cost-reduction program through mechanization



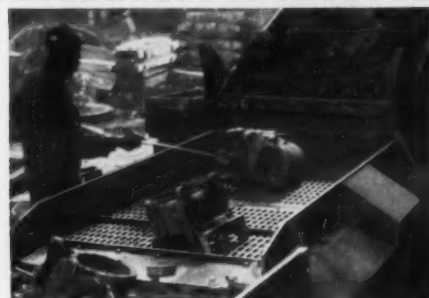
DRYERS — Link-Belt Roto-Louvre uniformly dries and cools large tonnages of sand in small space.



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BELT CONVEYORS — efficiently move sand. Plows discharge sand to molding stations as required.



SHAKEOUTS — complete line provides high speed, economical separation of sand and castings. Rugged two-bearing vibrator imparts smooth circular motion to all screening surface.



REVIVIFIERS thoroughly aerate molding sand so that it will flow easily . . . assuring even distribution around the pattern. Revolving blades break up any lumps.



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CONVEYORS AND PREPARATION MACHINERY

LINK-BELT COMPANY: Executive Offices, Prudential Plaza, Chicago 1. To Serve Industry There Are Link-Belt Plants and Sales Offices in All Principal Cities. Export Office, New York 7; Australia, Marrickville (Sydney); Brazil, Sao Paulo; Canada, Scarborough (Toronto 13); South Africa, Springs. Representatives Throughout the World. 14,983



CLEVELAND, MAY 19-23, BOOTHS 1635-37.

Circle No. 748, Page 7-8

ences attracted 40 representatives of 20 Michigan manufacturing firms to the Saginaw Malleable Iron Plant in December. E. E. Braun, works manager, Central Foundry Div., served as program chairman. The event featured a series of technical talks on latest foundry techniques.

American Welding Society . . . has formed a committee to review the recently prepared *Manual of Arc Welding*, a training publication said to supply industry and vocational training centers with factual, authoritative information on arc welding, following the practices approved and recommended by the A.W.S.

Beloit Eastern Corp. . . . Downingtown, Pa., has doubled the size and productive capacity of the Downingtown Mfg. Co. since purchasing the plant in 1956. Floor space has been increased from 99,000 to 200,000 sq ft, with employment jumping from 285 people in 1956, to just under 800. The firm builds massive, precision papermaking machinery for mills in this country and abroad. One papermaking (newsprint) machine is longer than a football field, as tall as a two-story building, and weighs in excess of five million lb. To keep

pace with the ever increasing requirements and demands of paper companies, Beloit Eastern has carried out a program of rapid expansion with particular attention to training new highly skilled craftsmen.—E. C. Klank

Shallway International Corp. . . . Palo Alto, Calif., a foundry equipment export firm, is hosting foundry managers of two large Yugoslavian foundries on a three-week tour of foundries in Los Angeles, Milwaukee,



Cleveland, and Pittsburgh, Pa. They are here to study American shell mold and shell core techniques. The touring foundrymen, Ing. M. Tomovic, Petar Drapshin Foundry, Belgrade, Yugoslavia; and Ing. B. Mrakovic, of the Yugoslavian government's Valjevo foundry are both active in the foundry society of Yugoslavia; Mrako-



Fifty years active service . . . Goff Smith, right, president, Griffin Wheel Co., Chicago, congratulates C. A. Groneman, office manager, Kansas City plant, and presents a gold watch to him at a recent dinner given by the company in Kansas City honoring 23 veteran employees of the plant. Groneman has been with the company since 1906. The firm which manufactures railway car wheels, has organized a Veteran Employees Club with chapters at each plant location and at the general offices. Every employee who had completed 25 years of service in 1957 or previously became a charter member. All retired employees are honorary members. In the future, employees will become club members on their 25th anniversary and will be honored at the annual dinner of their chapter. Watches have been presented to 155 active charter members, six of whom are women, who represent 5343 years of service, averaging 34½ years.

USE TASIL NO. 101 PATCH

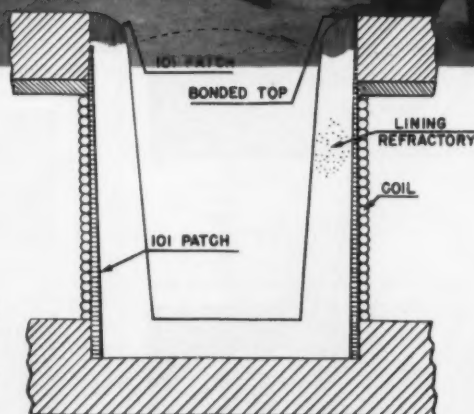
for high frequency
induction furnaces

TASIL (Taylor Sillimanite) No. 101 Patch is widely used by operators of high frequency induction furnaces for coating of the inner surface of the water-cooled, primary coil. When air dried, this coating will:

1. Protect the coil when the crucible is being rammed in place.
2. Protect the coil from damage in the event of a leakage of metal through the lining proper.

Properties which qualify TASIL No. 101 Patch for this service are: *high dielectric strength . . . smooth working properties . . . softening point above 3200° F. . . negligible shrinkage or expansion . . . can be used with either an acid or basic lining.*

There is a complete line of TASIL (mullite), TAYCOR (corundum-base) and TAYLOR ZIRCON Ramming Mixes and Cements for every metallurgical need. Write for recommendations to cover your melting requirements.



vic is president of the Valjevo chapter of that organization.

Pittsburgh Coke & Chemical Co. . . . has become the second non-captive blast furnace producer of ferromanganese in the United States, making its first production run from one of the company's Neville Island, Pa. blast furnaces. The product is necessary to the production of steel as a cleansing and alloying agent. Adaptation of the firm's blast furnace for producing the strategic metal cost approximately two and one-half million dollars, half of which bought a specialized gas cleaning system for prevention of air and stream pollution.

Casting Engineers Inc. . . . Chicago, reports that the company will introduce a new concept in precision fabrication within the next two years said to provide the customer with parts having the advantages of investment castings plus features of precision forming such as close tolerance and high density and strength. According to a company official, the cost will be lower in most cases than when a specific production method is used alone. The new process is claimed to provide average dimensions of plus or minus 0.003 in. and plus or minus 0.001 in.-tolerance. Officials state that the process is not restricted to relatively mild alloys because it utilizes investment casting as the primary operation.

Eastern Foundry Co. . . . Boyertown, Pa., has erected a new building which adds 20,000 sq ft of space for the production of cast iron boiler sections, bases, and burners which the company makes for the Peerless Heater Co. of Boyertown. The new structure is said to more than double the firm's output of castings.

American Foundry & Machine Co. . . . Salt Lake City, Utah, Div., Eimco Corp., has developed a new steel (critical hardness, Rc60-Rc62) said to overcome the principle limitation in using cast steel as a die material. The manufacturer claims that through alloying and heat treatment, the necessary gall resistance is achieved. Utah Die Steel has replaced forged steel in certain dies and punches.

Birdsboro Steel Foundry & Machine Co. . . . Birdsboro, Pa., reports an all time high sales and net income for 1957. The company states a net sales figure of approximately 22 million dollars for 1957, as compared to approximately 19 million dollars in the previous year; net income, \$880,403 in 1957; and \$868,768 in 1956. A company spokesman reports that



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Circle No. 749, Page 7-8

the present backlog and anticipated orders indicate sales and net income for 1958 will exceed last year's record amount.

A. P. Green Fire Brick Co. . . . Valentine Div., held an open house in January as company officials introduced the new one and one-half million dollar semi-silica firebrick plant at Woodbridge, N. J. The structure covers 18 acres and employs 150 people; it was constructed to replace the old Valentine plant almost com-



pletely destroyed by fire in October, 1956. Officials state that to assure quality control throughout all phases of production, the most modern equipment and automatic control devices have been installed.

Crouse-Hinds Co. . . . Syracuse, N. Y., has inaugurated a "good housekeeping" contest within the company's plant. There are four classifications,



three within the factory, and one for the office; each department competing only with departments in its classification. An inspection team makes unannounced monthly inspections, and the plaques are rotated every three months to winning departments. The accent is on safety and neatness.

Caterpillar Tractor Corp. . . . Peoria, Ill., in its annual report to stockholders, states that 1957 was a sharp

COMPLETE CORE IN 3 MINUTES

Rammed, Gassed and Removed!



1. The flowable CO₂ sand mixture is easily rammed by hand. (Shooters or blowers can also be used.)

2. Split second gas-sing eliminates the need for oven baking.

3. Instantly — the core is ready for the molding operation.

The CO₂ process proves to be a fast and economical method for core production at the J. M. Bruce Foundry in Cedar Grove, Wisconsin.

CO₂ PROCESS INCREASES CASTING CAPACITY . . . CUTS EQUIPMENT COSTS . . . ELIMINATES CORE STORAGE!

Glen and Mark Bruce, who operate the 40 year-old J. M. Bruce Foundry Co., are enthusiastic about the use of CO₂. An actual cash savings of thousands of dollars is reported due to the decrease in baking equipment and core storage. Valuable floor space previously used for core storage is now allocated to actual production use.

For J. M. Bruce Foundry Co. the big advantages in CO₂ are the increased size of the castings they can pour (without buying special core equipment)—50% reductions in core costs . . . virtual elimination of "plows" . . . no danger of drops, soft or wet spots . . . reduced core handling, extreme speed and flexibility in supplying core needs, and *making cores only when they need 'em*.

Get the facts on CO₂ core and mold making—complete information sent upon request.

World's Largest Producer of 
LIQUID CARBONIC
DIVISION OF GENERAL DYNAMICS CORPORATION
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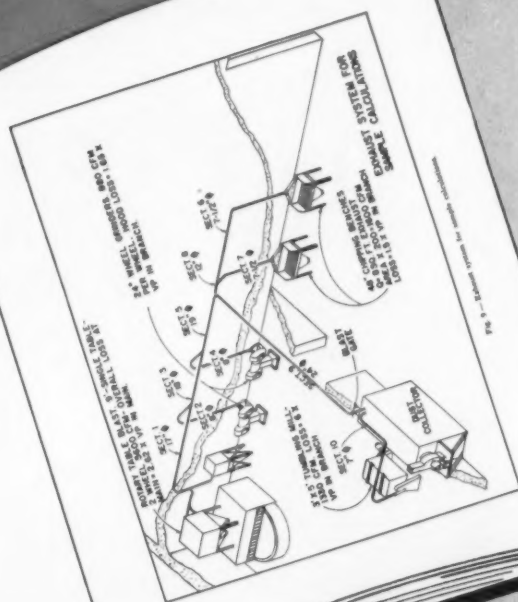
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for **FOUNDRY
ENVIRONMENT
CONTROL...**

ENGINEERING MANUAL FOR CONTROL OF IN-PLANT ENVIRONMENT IN FOUNDRIES



AMERICAN FOUNDRYMEN'S SOCIETY



Prepared

as 11 individual sections, this
8 1/2"x11", casebound book totals 152
information-packed pages, including 221
figures, 25 tables and numerous equations.

SECTIONALIZED EDITORIAL TREATMENT

- Sec. 1—General Principles of Foundry Ventilation and Foundry Hygiene Problems
- Sec. 2—Exhaust Hoods and System Design
- Sec. 3—Practical Design of Sand-Handling Ventilating Systems
- Sec. 4—Molding and Core Making Problems
- Sec. 5—General Principles for Melting and Pouring Operations
- Sec. 6—Cleaning Room
- Sec. 7—Housekeeping and Miscellaneous Control Measures
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Through adoption of wide-scale Safety Practices and Plant Modernization Programs, the foundry field has embarked on a crusade for unbiased acceptance among neighborhoods . . . workers . . . industry.

In line with the objective, and developed under direction of the AFS Safety, Hygiene and Air Pollution Control Program, **ENGINEERING MANUAL FOR CONTROL OF IN-PLANT ENVIRONMENT IN FOUNDRIES** is designed to:

1 "Assist in the standardization of dust eliminating equipment and improvement of shop operating conditions."

2 "Promote standards for dust elimination and control equipment in cooperation with manufacturers of such equipment."

Here is a factual . . . a reliable . . .

foundry reference. It is the kind of dependable, thought-provoking material that should be readily available to every foundry engineer. Copies of **ENGINEERING MANUAL FOR CONTROL OF IN-PLANT ENVIRONMENT IN FOUNDRIES** should be on the work tables of management teams in both large and small plants.

AMERICAN FOUNDRYMEN'S SOCIETY

Golf & Wolf Roads, Des Plaines, Illinois

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year of contrasts. The year began with the company's machines in short supply being rationed to dealers. Sales for the first half of the year were well above those for a comparable period of 1956. In the third quarter, there began a downturn, which became a steep slide in the fourth quarter. As a result, sales and profits for the year did not surpass those of 1956, however, they were the second best in the history of the company. As a result of the decline in business, Caterpillar has reduced the size of its work force, shortened the work week, and curtailed operating expenses.

Allegheny Ludlum Steel Corp. . . . Pittsburgh, Pa., has erected a new office building in West Leechburg, Pa., to house the office force and engineering sections of the company's West Leechburg Works. The outside



wall design of the structure is composed of four sq ft, 20-gauge, type 202 stainless steel panels. About 20,000 lb of stainless steel were used in the building, which is of a curtain wall design on a structural grid system.

Dike-O-Seal Inc. . . . Chicago, announces that Klein-Farris Co., Boston, will be the exclusive New England agent for Dike-O-Seal products. The New England states will be covered by H. H. Klein, George Liff, and John Waddington.

Allis-Chalmers Mfg. Co. . . . Milwaukee, has announced plans for new engineering, development and research laboratories to be constructed near Milwaukee. A staff of 150-200 scientists, engineers, draftsmen, technicians, and administrative personnel will be employed at the 30-acre site.

Precision Founders Inc. . . . San Leandro, Calif., has announced the purchase of the Mars Mfg. Co., San Francisco. The acquisition was made to increase wax injection die making capacity at the new San Leandro plant.

Material Handling Institute, Inc. . . . has reported that a management survey of the 86 firms composing mem-

bership of the organization indicates a belief that the first half of 1958 should reflect material handling equipment sales about equal to the last half of 1957. An upswing is forecast for the latter part of the coming year.

Barber-Greene Co. . . . Aurora, Ill., has announced affiliation with C. & S. Products Co., Inc., Detroit. Barber-Greene is said to be the world's largest manufacturer of asphalt mixing and paving equipment; and a leading producer of materials handling machinery.

Link-Belt Co. . . . Chicago, has opened a new district sales office in New Orleans, La.

C. I. T. Corp. . . . New York, has opened a new division office in Denver, Colo. The company finances many types of industrial equipment and machinery.

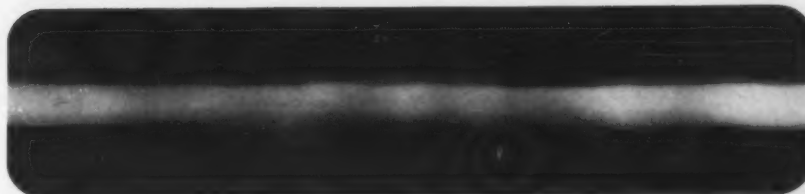
Pittsburgh Coke & Chemical Co. . . . Pittsburgh, Pa., has announced in its year-end report that the company had strengthened its overall position by completing major expansion and diversification projects during 1957. A new cement research laboratory will be in operation early in 1958 according to company officials.

The Trane Co. . . . La Crosse, Wis., has opened their new million-dollar manufacturing plant in which heat exchangers for multiple purposes including heat dissipation in guided missiles and jet aircraft are manufactured. The 76,800 sq ft production facility represents one of the final phases of a two-year 13 million dollar building and expansion program in La Crosse.

Ohio Ferro-Alloys Corp. . . . Canton, Ohio, has put into production the first of three large electric submerged arc furnaces to be installed at the company's new reduction plant located near Powhatan Point, Ohio. The modern furnaces produce silicon metal for the aluminum and chemical industries, as well as high-grade ferro-silicons for the iron and steel industry. The new plant, when completed, will cost in excess of three million dollars.

Brush Beryllium Co. . . . Cleveland, has purchased the assets of Penn Precision Products, Inc., Reading, Pa., and will continue operation of the precision strip producing facility under the name, Pennrold Division.

Continued on page 135



Heavy sections like rudder posts and propeller blades can be gamma ray inspected with $\frac{1}{3}$ shorter exposure—and welded seams can be radiographed more rapidly with available portable or low kv x-ray equipment—when Kodak Industrial X-ray Film Type KK is used.

... cut exposure time $\frac{1}{3}$ with New Kodak Industrial X-ray Film TYPE KK



Where heavier sections are to be radiographed or where the output of available x-ray or gamma ray sources is limited, Kodak's new Industrial X-ray Film Type KK is the film to use.

This film shows as much as 50% increase in speed over the well-known Type K Film. It means more work can be done—that exposures can be cut by

a third. And those who have tried Type KK tell us that its higher contrast, offsetting a slight increase in graininess, provides improved radiographic sensitivity.

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Circle No. 752, Page 7-8

Kodak



Foseco® FEEDEX®

PREFABRICATED SLEEVES*
for better castings... all the time!

Foseco FEEDEX, exothermic anti-piping sleeves, offer your foundry advantages you've never believed possible! FEEDEX sleeves

- eliminate shrinkage
- keep feed metal molten longer
- aid directional solidification
- permit reduction in riser size—more castings from each heat
- reduce melting and cleaning costs
- do not alter chemical and physical properties of the metal

FEEDEX sleeves come in easy-to-store cartons, are available in a complete range of sizes and shapes for all metals. Ask us about applications in your foundry.

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Circle No. 753, Page 7-8

let's get personal

Dr. B. D. Thomas . . . has been elected president of the Battelle Memorial Institute. Since 1934, he has been associated with the Institute's executive and technical staff, and has served as director since December, 1956. Dr. Thomas established Battelle's first Division of Chemical Research in 1939, and assisted in the establishment of Institute research laboratories in Frankfurt, Germany, and Geneva, Switzerland.

E. J. McAfee . . . formerly master patternmaker for the Puget Sound Naval Shipyard, Bremerton, Wash., has retired and plans to make his home in Hawaii. He was awarded an honorary life membership in AFS in 1951 "for outstanding service to the Society and to the foundry industry in the development of patternmaking materials and applications." A patternmaker since 1907, McAfee joined the shipyard in 1916, becoming master patternmaker in 1938. He received the Navy's Meritorious Civilian Award in 1949 for his work in producing new patternmaking methods. In addition to his many articles on patternmaking, McAfee is co-author of the AFS PATTERNMAKERS' MANUAL; and currently serves as Chairman of the AFS Pattern Manual Committee; member of the AFS Executive Committee, Pattern Division; and member of the AFS Apprentice Contest Committee.

Carter Kissell . . . has been elected

president of National Malleable & Steel Castings Co., Cleveland; and C. H. Pomeroy named chairman of the board of directors. Kissell became the company's legal counsel in 1941, and a director in 1954. Associated with the company since 1920, Pomeroy was elected president in 1946. The company's Cleveland Technical Center and Indianapolis Process Development Foundry were started under his leadership.

Ernest Swaine . . . has been newly elected to president and general manager of the Dixie Tool Co., Bridgeport, Mich. Other promotions include; **Milo Shaner**, vice-president and assistant general manager; **Donald Alexander**, treasurer; and **Raymond Johnson**, secretary.

G. A. Colligan . . . Instructor of Metal Engineering at the University of Michigan, has been named new chairman of the AFS Research Committee, Steel Division.

R. F. Forsythe . . . past chairman of the AFS Tri-State Chapter and assistant superintendent of the Big Four Foundry, Tulsa, Okla., has taken a new position as general manager of the Pampa Foundries, Pampa, Texas. He was with the Tulsa company for 12 years.

O. J. Myers . . . Reichhold Chemicals, Inc., White Plains, N. Y., and AFS Region 1 vice-president, toured the western chapters of AFS during



E. J. McAfee



C. Kissell



R. F. Forsythe

March. Speaking on sand and core-making, Myers addressed the Southern California, Northern California, Oregon, Washington, British Columbia, and Utah chapters.

G. H. Dennison . . . has been made general manager in charge of sales for Keystone Abrasive Wheel Co., Carnegie, Pa. He was associated with Carborundum Co., Niagara Falls, N.Y.

T. H. Brumagin . . . Ajax Flexible Coupling Co., Inc., Westfield, N. Y., has recently been appointed general sales manager. He has been asso-



T. H. Brumagin

ciated for 11 years with the firm which produces flexible couplings, vibrating conveyors, screens, and reciprocating drives.

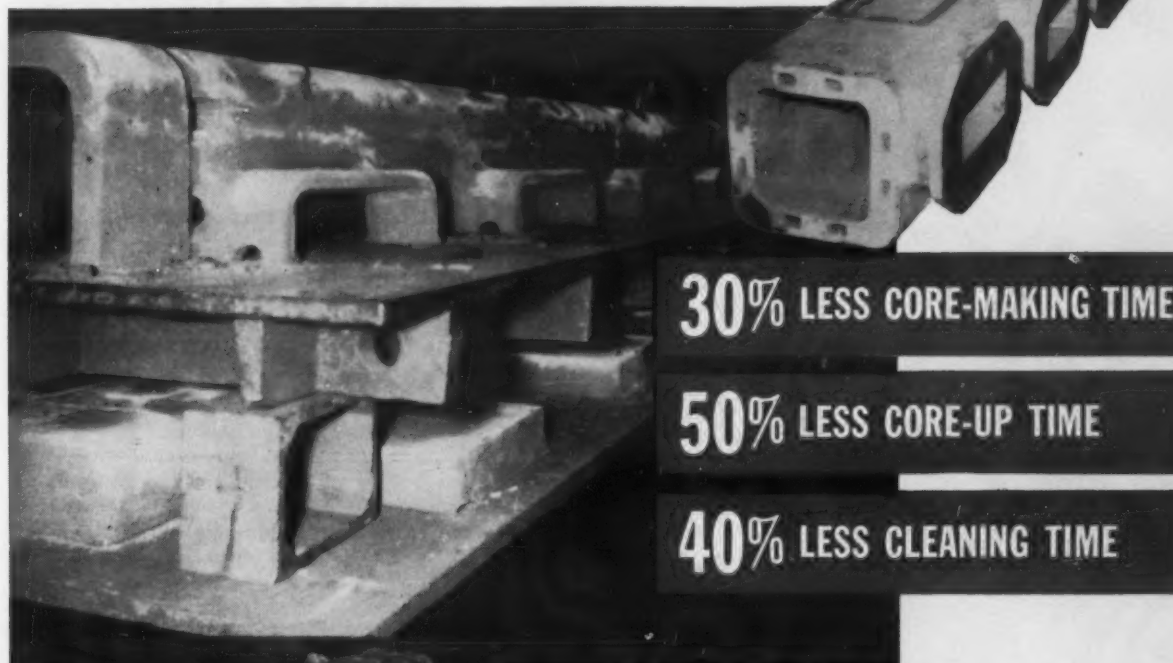
G. C. Curry . . . has been appointed general sales manager of Dollin Corp., Irvington, N. J. Before joining the company, which manufactures zinc and aluminum die-castings, Curry was affiliated with the Hoover Co., North Canton, Ohio, for 26 years.

W. M. Troutman . . . is the new vice-president of General Refractories Co., Pittsburgh, Pa. He joined the company in 1947 as a member of the Pittsburgh district sales force, and was promoted to district sales manager in 1954.

R. M. Ovestrud . . . has been named to a newly created position, manager of research and development, for the Foundry Products Div., Reichhold Chemicals, Inc., White Plains, N. Y. This new appointment is said to be the first of a series of moves to expand the company's Foundry Products Division. Ovestrud was previously chief metallurgist for the Rhuda Media Co., Marble, Minn.

Bruce Mayo . . . has been appointed as district manager for the Birmingham, Ala., district office, Link-Belt Co., Chicago. He replaces **J. R. Arnold**, who is handling a special assignment at the company's Colmar, Pa.

FOR CLARK BROS. CO. MANIFOLD CASTINGS



30% LESS CORE-MAKING TIME

50% LESS CORE-UP TIME

40% LESS CLEANING TIME



Use of Kold-Set provides smoother casting surfaces, together with dramatic cost savings, for Clark Bros. Co. in production of manifolds for R A Type Compressors.

Core: Bed-in sand and driers are not needed. The cores retain excellent dimensional accuracy.

Core Setting: Conventional methods require one core setting for fitting, as well as a re-setting. Only a single setting is needed with Kold-Set.

A good deal of core rubbing has been eliminated and there is no bed-in sand to remove. This results in a better core surface while lessening the chance of loose bed-in sand causing dirt in the casting.

Casting and Cleaning: Casting surfaces are smoother due to elimination of bed-in sand. Hydro-blast time has been reduced by 50%, and there is less finish chipping. Due to superior venting in the Kold-Set sand mix and less gas potential in the cores after baking, blows in the cope of the casting have been eliminated.

Get the facts on Kold-Set. Ask for Technical Bulletins

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Push the button . . . then check your watch!

Rotoblast® cleans quickly and automatically . . . gives you more production with less manpower!

This control panel on the Pangborn Rotoblast Barrel is a symbol.

It stands for *speed*—push the Start button and a few minutes later you can push the one for Stop. It means *automatic operation*—just one man is needed to run it. And *quality*, too—between Start and Stop, whirling Rotoblast thoroughly blast cleans your castings to a silvery finish.

From original engineering through rugged construction to expert installation, Pangborn Rotoblast Machines are designed to satisfy you on every count—speed, performance, maintenance.

The Pangborn Engineer in your area will be glad to take off his coat and go to work on your cleaning problem at no obligation. And, for more information, write today for Bulletin 227 to: PANGBORN CORP., 1300 Pangborn Blvd., Hagerstown, Md. Manufacturers of Blast Cleaning and Dust Control Equipment.



Pangborn Rotoblast Barrel for efficient batch cleaning. Available in 1½, 3, 6, 12, 18, 30 and 72 cubic foot sizes.

Clean it fast with

Pangborn

ROTOBLAST

plant. Mayo has been with Link-Belt since 1945.

A. J. Jackman . . . is now vice-chairman of the board, Vesuvius Crucible Co., Swissvale, Pa. He was formerly president of the firm, the position to which T. H. Harley has been elected.

J. P. Cullen . . . has been named manager of clamshell bucket sales for Blaw-Knox Co., Pittsburgh, Pa. He succeeds Arnold Hooper, whose retirement was recently announced. Cullen has been west coast manager for the company since 1951.

J. W. Brown, Jr. . . . Brown Thermal Development Co., subsidiary of Brown Fintube Co., Elyria, Ohio, is leaving for Europe to confer with the company's licensees in Germany and Eng-



J. W. Brown, Jr.

land to discuss the Brown systems of heat recovery and blast heating for cupolas in iron foundries. He will make a study of their foundry techniques of air blast heating.

Dr. F. N. Darmara . . . general manager, Utica Metals Div., Kelsey-Hayes Co., Detroit, has been named to the sub-committee on power plant materials of the National Advisory Committee for Aeronautics for 1958.

T. T. Arden . . . has been made president of the Robertshaw-Fulton Controls Co., Long Beach, Calif. He maintains his offices at Richmond, Va.

W. F. Pravel . . . recently has been appointed supervisor, tool steel development, application and development department, Allegheny Ludlum Steel Corp., Pittsburgh, Pa. He joined the company in 1934. In his new post, Pravel will investigate new potential markets for tool steel.

D. R. Dunlap . . . has been appointed superintendent of malleable operations General Motors Corp., General

Foundry Div. plant in Defiance, Ohio. Other new appointments at the company's Saginaw Malleable Iron Plant, Saginaw, Mich., are: **C. W. Meyer**, superintendent, shell department; **R. J. Gleffe**, superintendent, corer room; and **W. C. Corbin**, plant personnel director. Additional appointments include **W. L. Nalevayko**, to superintendent, pattern shop; and **J. A. Kenney**, to general foreman, corer room.

F. P. Morrow . . . has recently joined the staff of Superior Foundry Inc., Cleveland, as sales engineer. Morrow has served for eight years with the



F. P. Morrow

Standard Alloy Foundry, Cleveland, and for ten years with Robinson Tool Fabricating Co., Cleveland.

Richard Lewis . . . is now manager in charge for General Electric Co.'s Foundry Department. He has been with the company since his graduation from the University of Indiana in 1947.

J. W. Corrigan . . . has been named vice-president of the J. C. Corrigan Co., Inc., Boston. The company manufactures conveying systems.

L. J. Pedicini . . . Tann Corp., Detroit, has been appointed manager of manufacturing engineering of the company's Congress Die Casting and Congress Drives divisions. He is in charge of planning and directing the activities of the design engineering, plan engineering, industrial engineering, and maintenance departments of both Congress divisions. **A. W. Kurz, Jr.** is the new manufacturing manager for these two divisions. Pedicini is a member of the board of directors, AFS Detroit Chapter, and Vice-Chairman of the AFS Sand Division.

P. L. O'Neill . . . is now executive vice-president and general manager

Continued on page 151



CASTINGS TO KEEP TRAFFIC MOVING SMOOTHLY—Giant castings, such as these used in highway tunnels, are another example of how the foundry industry contributes to progress.

TRULINE® BINDER ENDS FOUNDRY TRAFFIC JAMS

Foundries can't afford traffic jams. That's where Truline comes in—helping to keep castings moving on schedule and preventing oven bottle-necks.

In the core room, in the oven, in the cleaning room, Truline Binder avoids delays every step of the way. For example, Truline's quick bake

often makes it possible for one oven to do the work of two. Cores bonded with Truline collapse readily; are easily removed by hydroblast or knockout.

To learn more about how Truline can help keep your foundry on schedule, write for full information.

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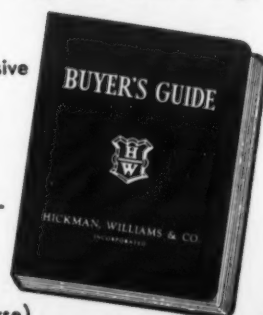
Circle No. 756, Page 7-8



Guide to Quality

Yours for the asking... the Hickman, Williams comprehensive Buyers Guide... covers in detail all essential basic foundry commodities: Pig Iron—Silvery—Fe Phos—Coke—Shot—Grit—Clays—Sands—Coals—Fluxes—Spiegel—Refractories, etc.

For your copy (Gratis, of course) contact nearest Hickman, Williams office.



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the SHAPE of things

safety, hygiene, air pollution

by HERBERT J. WEBER



Rx-THREE SHOTS OF WHISKEY DAILY FOR LEAD POISONING

A few years ago I was called in on a compensation case. The plaintive had been working in a brass foundry and claimed that he was suffering from lead poisoning due to inhaling lead dust; that he was thereby partially disabled and found it necessary to seek medical treatment.

When asked what kind of treatment he received, he testified that his doctor prescribed three shots of whisky daily "to wash the lead dust down his throat." This is probably a pleasant form of treatment but of doubtful therapeutic value.

Similar fallacies are frequently quoted in the press resulting in the public acceptance of misinformation. Here are a few quotes:

- 1) "Lead poisoning may be regarded as a counterpart of syphilis."
- 2) "Lead poisoning is probably the most important of known toxic hazards incident to the development of our civilization."
- 3) "Lead intoxication is the most important industrial poisoning, forming the basis for a large proportion of the total claims for compensation."

Here's another one, and I quote from Dr. Rutherford Jonstone. "I wonder if you heard of the man in El Monte, California, who, in a fit of rage, poured white enamel over the upper part of his wife's body, then held her by the feet and painted the lower body with black enamel. Amusing, but even more so, was her physician's statement that he feared for her life because of *lead absorption*." Hard to believe, isn't it!

Now let us consider some facts about lead poisoning. Lead may enter the body in one or all of three ways. These may be called the three "I's" in order of their importance:

- 1) *Inhalation* of fumes from melting at high temperatures lead or materials containing lead, or inhalation of dusts from grinding and chipping leaded brass castings. Inhalation is the most important form of entry from the foundry standpoint.

- 2) *Ingestion*, or swallowing of lead dusts or materials. This is not industrially important.
- 3) *Inunction*, or absorption through the skin. This occurs only with organic compounds of lead such as tetraethyl lead in gasolines. It is of little concern in the foundry industry.

Lead poisoning is characterized by such symptoms as: colic, constipation, metallic taste, and nausea in the morning.

A more severe symptom is paralysis of the nervous system.

There is a difference between lead absorption and lead intoxication. By the former is meant that lead is present in the body in greater amounts than normal but not in sufficient quantity to cause symptoms. Lead can be found in the blood of all persons—even new-born infants. This is due to traces of lead in the air we breathe and the food we eat.

The mere fact that men work in a brass foundry does not warrant a diagnosis of lead intoxication if they have an upset stomach... the upset may be from the whisky treatment.

On the other hand, the fact that a brass founder never suffered from lead poisoning, even though there was sufficient exposure, does not mean that he will never be afflicted.

A case in point is a foundryman who was exposed for 38 years but never had a symptom or sign of lead poisoning. Finally, the defensive mechanism of his body could no longer protect, and he suffered a paralyzed bowel, wrist drop, halting walk and severe anemia with marked loss of weight.

Many blood transfusions were given but this man was unable to recapture his former robust health.

Lead poisoning, unlike silicosis, can be treated and cured. It does not necessarily leave a permanent injury. But like silicosis the best treatment is prevention.

By the way, our plaintiff died of lead poisoning... a neighbor shot him when he caught him misbehaving.

Foundry Trade News

Continued from page 129

The Brush Beryllium Co. officials state that the newly acquired facilities will allow expansion of service to customers for finished strip, while developing new production techniques and alloy specifications on its whole range of alloys and products.

General Electric Co. . . . Chemical and Metallurgical Div., Pittsfield, Mass., announces that phenolic resin manufacturing facilities have been completely rebuilt and are now in full operation, producing resins for commercial sale and for incorporation in General Electric phenolic molding powders.

American Die Castings Institute . . . reports an all-time high production record for aluminum die castings in 1957, while the nation's output of zinc die castings was exceeded only by the peak year of 1955. The Institute predicts that the trend of increased die casting usage will continue, reaching 395 million lb of aluminum and 347,000 tons of zinc die castings this year.

Gulton Industries, Inc. . . . Metuchen, N. J., has established five new district offices. Located in Atlanta, Ga.; Boston; Denver; Miami, Fla.; and San Francisco; these offices represent a 100 per cent increase in the company's national sales organization. The firm is said to be one of the nation's leaders in development and production of ultrasonic equipment and systems.

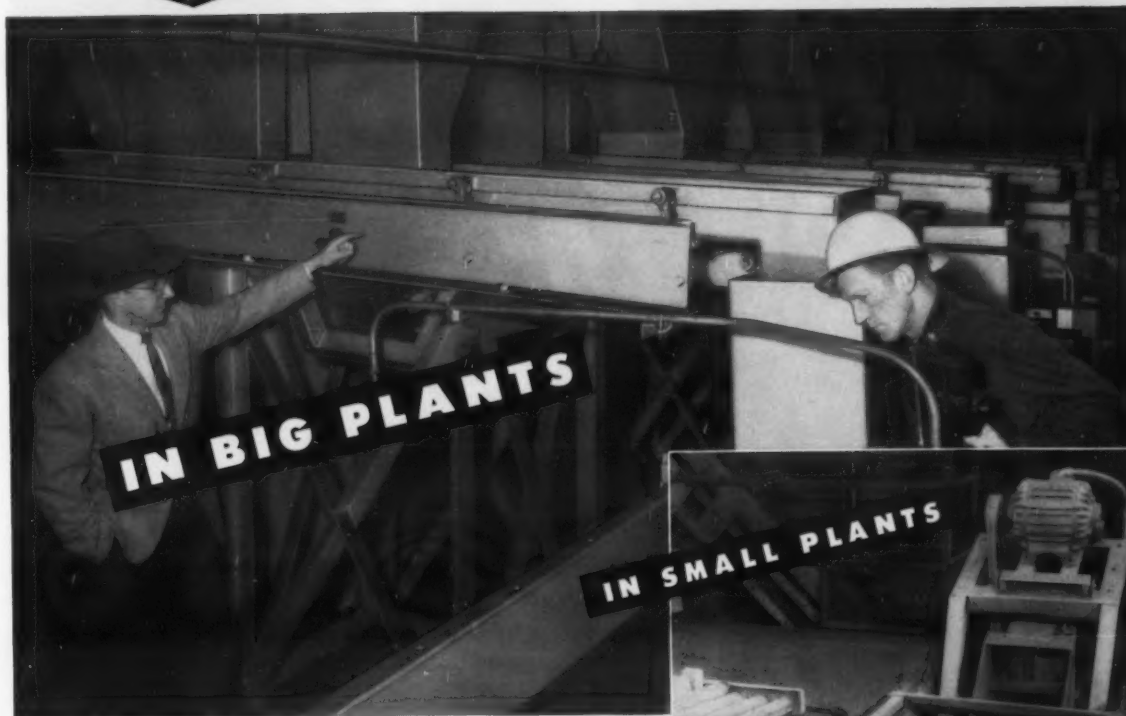
Royer Foundry & Machine Co. . . . Kingston, Pa., has retained W. P. Winter, Pennsylvania State University, to prepare a series of articles on practical sand conditioning for the company's house organ. *Sand Conditioning Topics.*

New York Testing Laboratories . . . New York, has installed an 11-ft long environmental walk-in chamber with a temperature range of minus 85 to plus 250 F, and a relative humidity range of 95 per cent, plus or minus five per cent. This unit was designed to accommodate the largest and bulkiest products which previously could not be subjected to the important controlled rain, sand, dust, and freezing rain tests.

Core-Lube, Inc. . . . Danville, Ill., a new organization consisting largely of former Swan-Finch Petrochemicals Corp. employees, has announced that the company is now in a position to supply many lubricating oils, core



LO-VEYORS are cutting costs



Above photo shows how Ajax Lo-Veyors are used as feeders from spill sand hoppers to collecting belt in sand reclamation system of modern automotive foundry.

Plant layout men are specifying Ajax Vibrating Type Lo-Veyors as integrated equipment for handling bulk materials. They simplify processing operations in every step from raw materials to finished products.

Open or closed pan and tubular types meet every requirement of tonnage, speed, sanitation, contamination, abrasive and explosive conditions.

Simplified reciprocating drive eliminates head, tail and idler pulleys subject to wear and high cost maintenance.

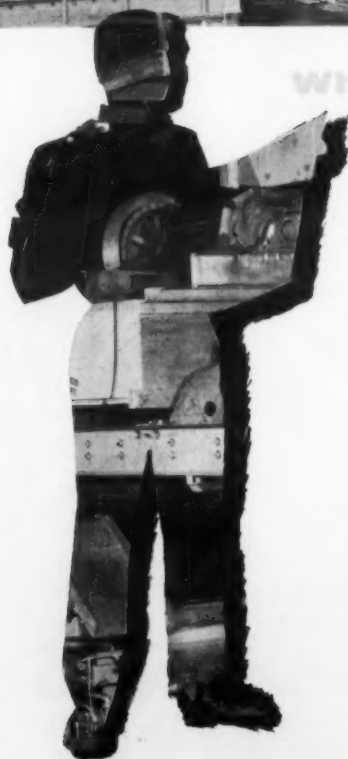
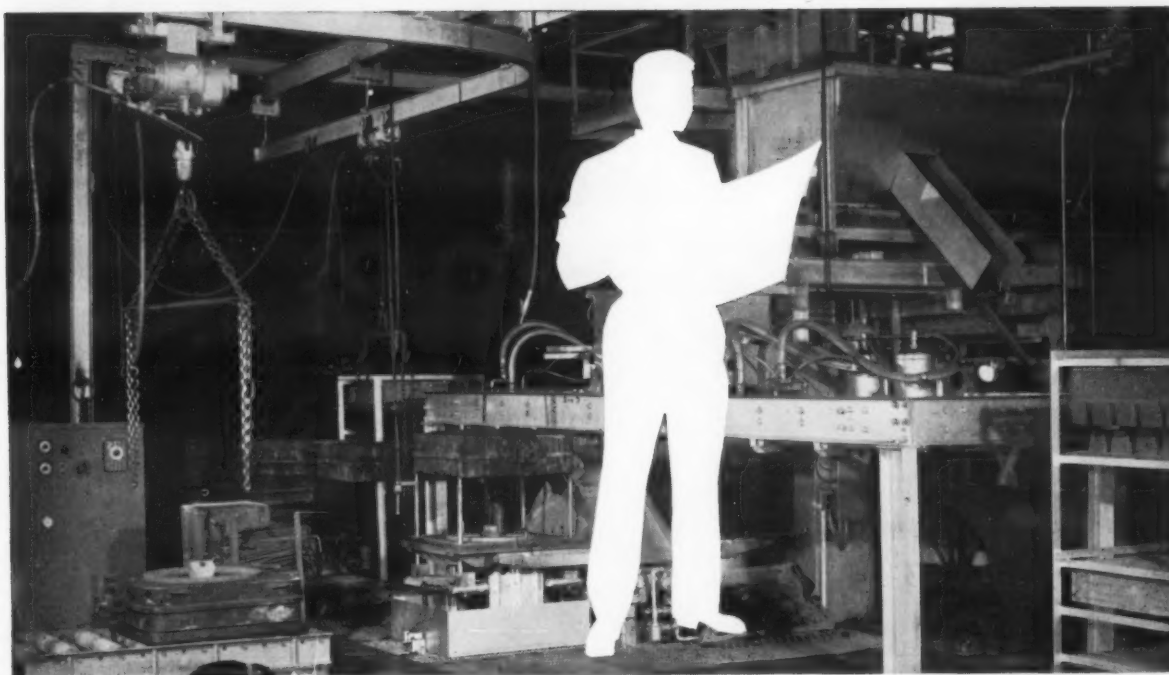
Ajax Lo-Veyors can be installed at or below floor level and can be suspended from wall or ceiling with suitable support structure. Ajax Lo-Veyors are incorporated as original equipment by manufacturers of materials handling systems. They are widely used as individual conveyor, feeder and multi-purpose units for in-plant layouts.



Photo shows how Ajax Lo-Veyors are used to speed up sand reclamation and cut handling costs in small, non-ferrous foundries. Core bits, lumps and tramp metal is removed from shake out sand as it is returned to system.

Write the factory for full information and name of the Ajax application man as near your telephone.

AJAX FLEXIBLE COUPLING CO. INC.
WESTFIELD, N. Y.



Who is your foundry's future?

Stand back for a moment and look at your foundry. Strip it down to its components. What gives it substance?

"Man, of course", you say, "the individual who blends the ingredients into a productive whole."

And it is also upon man that the growth and development of your foundry depend . . . man technically trained and soundly indoctrinated in the field of foundry science and engineering.

But what investment are you making in that man; what are you contributing to his education today, for your greater benefit tomorrow?

Through the efforts of the Foundry Educational Foundation, and its participating members, about two hundred fifty graduate engineers are available to the foundry and allied industries annually. How many will your foundry absorb to insure its future; how many can you claim as a big return on a small investment?

Write today for our detailed booklet, "Let's Look Ahead".

Foundry Educational Foundation

1138 TERMINAL TOWER BUILDING • CLEVELAND 13, OHIO



binders, and cutting lubricants comparable to those previously obtainable from Swan-Finch. The new company was formed after the manufacturing and shipping operations of Swan-Finch were terminated by the receivers.

Dow Chemical Co. . . . Midland, Mich., has opened a new sales office in Dallas, Texas. Officials state this new office marks another step in the company's long range expansion plans to improve service to markets in growing industrial areas.

Palmer-Bee Co. . . . Marysville, Mich., has formed the Autocon Div. at Pontiac, Mich. to fabricate custom electrical control panels for conveyors and machine tools, and to design and engineer completely integrated electrical control systems.

C. S. R. Chemicals Pty. Ltd. . . . of Australia, has announced it will start producing high impact polystyrene plastic in May under license from the Dow Chemical Co., Midland, Mich. Dow engineers assisted in planning the plant nearing completion at Rhodes, N. S. W. The plastic is said to be widely used for molding, extrusion, and vacuum forming for industrial and household appliances.

New Bi-metallic Bonding Process for Die Castings

■ A new mechanical bonding technique which effects a strong bi-metallic-interlock between aluminum die cast automobile wheels and centrifugal cast gray iron brake drums, a process said to be superior to metallurgical bonding, has been developed by Doehler-Jarvis Div., National Lead Co., New York. The process permits an enlarged bonded contact area and creates excellent heat flow conditions between the gray iron brake liners and the aluminum wheels, promoting higher efficiency and greater safety.

To accomplish the union, the brake drum liner is inserted into the die cavity, the die is closed, and molten aluminum is injected under pressure of 6000-10,000 lb per sq in., forming the wheel and at the same time bonding it to the brake liner.

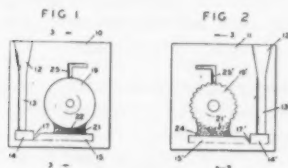
The company claims the new bond process has outstanding tensile and sheer strength; can be extended to all die casting metals, such as zinc, magnesium, and copper alloys; and can be used for many other bi-metallic applications previously involving an iron-aluminum intermetallic compound.

patent review

Molds with Traps

A method of trapping air and foreign matter in molten metal before it enters the casting cavity has been patented. The method is intended for use with resin-bonded sand molds.

The method provides for an ingate containing truncated cones (21) to be located between the runner and the casting cavity. The cones, ar-



ranged in staggered rows, are made integrally with the mold halves and are formed from the same molding sand.

The cones trap air and gases and the resin-sand mix from which they are formed provides an ample surface for absorbing the gases. The cones also serve as a pre-mixer which thoroughly mixes the molten metal, thus dispersing any alloying additives. *Pat. No. 2,788,554 issued April 16, 1957 to Charles C. Phipps and assigned to E. N. Harrison.*

Sand Reclaimer

A new sand reclaimer literally washes the sand clean. Used mold and core sand previously broken into granular size is charged continuously into a primary classifier together with water, forming a slurry. Fines, clay, and more buoyant foreign materials float to the surface and are discharged. The slurry of heavier sand particles drops into a scrubber.

The surface coating of carbon, clay, fines, and organic binder is removed from sand in scrubber. This waste is separated from the cleaned sand in a pumping tank. Only cleaned sand grains larger than a predetermined size are permitted to be discharged by gravity into a reservoir and then into a centrifuge and drier. *Pat. No. 2,783,511, issued March 5, 1957 to Phillip C. Will and Roy L. Luce, assigned to Hydro-Blast Corp.*

CAST METALS Handbook

**AUTHORITATIVE REFERENCE
FOR DESIGN-ENGINEERS**

**BASIC CREATIVE
KNOW-HOW IN METAL**

Industrial development, change and new product opportunities have created a demand for an essential engineering reference volume. The new Fourth Edition of the CAST METALS HANDBOOK brings existing information on cast metals up to-the-minute.

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Every chapter of the revised edition is reworked and augmented, with such completely new sections as: Casting Design, Cross Index of Equivalent Ferrous and Nonferrous Casting Alloy Specifications, Heat Treatment of Gray Iron, Pearlitic Malleable Iron, Nodular Cast Iron, Titanium-Base Alloys and Zinc-Base Alloys.



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- 1 Reliable working data for utilizing the properties of cast metals to the greatest engineering advantages.
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- 3 Practical, up-to-date facts on HOW to get the most out of castings designs.

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in the sale of 10,000 copies of the
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and enlarged. **EVERY MODERN-
THINKING PRODUCT-DESIGNER
NEEDS THIS HANDBOOK!**

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Des Plaines, Illinois

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here's how

■ Here's how **Light Alloys, Ltd.**, Haley, Ont., modified a fork lift truck for carrying and pouring ladles of magnesium. Truck is driven into melt room; melting pot is lifted from furnace and placed in cradle on front of truck; metal is delivered to pouring station; and metal is poured by mechanical tilting on a lip axis. Except for skimming and temperature measurement, pouring done by one man.—*L. G. Day, plant manager.*



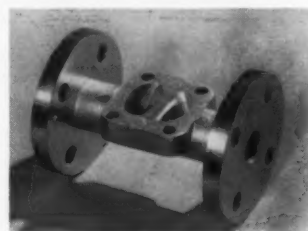
■ Here's how **Eddystone Div., Baldwin-Lima-Hamilton Corp.**, Eddystone, Pa., helps ship owners to save on operating and maintenance costs. Five-bladed, 21-ft Nialite propeller,

in use on a super tanker for three years, shows virtually no wear due to erosion or cavitation. Wheel was



cast as one piece in nickel-aluminum bronze alloy containing no zinc.

■ Here's how **Metals Div., Imperial Chemical Industries, Ltd.**, Birmingham, England, casts titanium valve bodies for chemical plant applications.



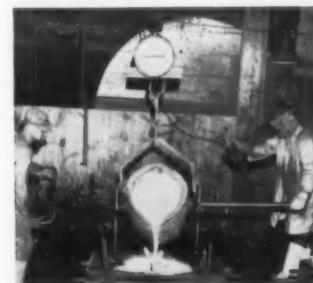
Bodies for 1-in. type "A" Saunders valves are now in production in prototype quantities.

■ Here's how **Chicago Pneumatic Tool Co.** uses a manganese bronze casting to replace a malleable casting. Air-hose coupling is now cast in manganese bronze because finished castings are inherently rust-proof,



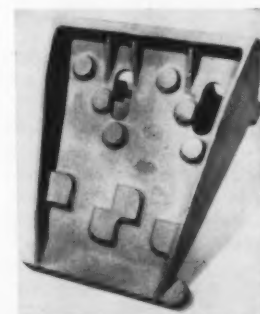
need no plating, and exterior surface does not require finish machining. Chicago Pneumatic's Utica, N. Y. plant produces over 150,000 couplings yearly. Castings are produced from alloy supplied by Federated Metals Div., American Smelting and Refining Co.

■ Here's how **Erie Foundries, Foundry Department, General Electric Co.**, weighs the metal tapped into a ladle. Malleable iron practices at Erie Foundries require accurate



ladle additions of manganese. By using the scale, no metal is left to be pigged and no manganese is wasted.—*P. W. Green, metallurgist.*

■ Here's how **Gaines Co.**, Rivera, Calif., light metals foundry cast magnesium-zirconium-thorium alloy in permanent molds. Alloy used is HK31.



All melting equipment used is new, to avoid any contamination. The 200-lb melt is brought up to 1475 F as rapidly as possible, then the magnesium-zirconium hardener is added, then the thorium required to bring it slightly above 3.0 per cent. A wet flux is used. Melt is held at 1475 F for about 20 minutes, then poured directly into molds.

■ Here's how **AlSCO Welding Co.**, Columbus, Ohio, repaired a 14-in. long crack in a 150-lb cast iron pulley



block. Ni-Rod "55" electrode was used for repair weld after block was preheated to 250 F. Block was ready for service in one day.

Use this "Answer-to-Casting-Troubles"

Casting metals at just the right temperature is what eliminates many "casting troubles". Where Marshall Enclosed-Tip Thermocouples are used in checking molten metal temperatures, many casting flaws are avoided, and sound castings result. Marshall Thermocouples are dependable instruments used everywhere in nonferrous foundries. They give prompt temperature reports from inside the melt, and can be relied upon for accuracy. Two convenient types are available: for ladle or furnace use.

Let our Catalog, sent free, give you more data. L. H. Marshall Co., 270 W. Lane Ave., Columbus 2, Ohio.

Circle No. 761, Page 7-8

for the asking

Build an idea file for plant improvements.
Reader Service Cards, page 7-8
will bring more information . . .

Annual Index . . . of 1957 issues of MODERN CASTINGS available free. Simple cross-reference designed to eliminate time and effort in finding metal castings information.

Circle No. 661, Page 7-8

Temporary help services . . . available to perform loading and unloading, maintenance, moving, factory and general labor on local, regional and national scale. Said to be largest firm of this type in United States and foreign countries. Solve your temporary help-wanted needs with this handy labor source. *Manpower, Inc.*

Circle No. 662, Page 7-8

Collective bargaining . . . do's and don'ts summarized in 10-p article. Stresses equalization of bargaining facilities by labor and management. Outlines preparation, presentation, analysis, objects to be attained, and pitfalls. *National Foundry Assn.*

Circle No. 663, Page 7-8

Industrial television uses . . . in steel industry explained in 4-p folder. Operation of closed-circuit installation case history given. TV system said to increase productivity, reduce costs, and save fuel in open hearth steel-making process. *General Precision Laboratory Inc.*

Circle No. 664, Page 7-8

Monolithic floor surfacing material . . . said to have a tenacity and bonding strength 40 times greater than concrete—explained in 8-p booklet. Typical installation in critical plant areas and out-of-doors shows how new flooring stands up under heavy truck traffic, destructive process solutions, and temperature changes. Test based on half-inch applications indicate a flexural strength 12 times greater than concrete and water. *The Master Mechanics Co.*

Circle No. 665, Page 7-8

Pallet care . . . and maintenance technical pamphlet prepared for industry. Utilizes materials handling methods in manufacturing, warehousing and transportation operations. In-

tended as guide to users in preventing damage to wooden pallets during use and in assisting in proper methods of maintenance once damaged. States life of pallet is 5-7 years and gives nine rules for care. *National Wooden Pallet Mfrs. Assn.*

Circle No. 666, Page 7-8

Electric furnace maintenance . . . an artistic picture, 11-3/4 x 10 in., of action in the foundry suitable for



framing. Your complimentary copy obtained by circling No. 667, Reader's Service Card, p. 7-8. *Great Lakes Carbon Co.*

Photodrawings . . . publication describes use of photographs to convey engineering drawing information in an easy-to-visualize form. Prepared in answer to requests of draftsmen, engineers and industry production men, material was previously mimeographed.

Simple technique of reproducing on translucent material onto which engineering detail and superimposed sketches are added. From master photodrawing, work prints can be made. *Eastman Kodak Co.*

Circle No. 668, Page 7-8

Chemical milling . . . literature of interest to design and production engineers. Discusses definition, advantages, application check list, metals that can be chemically milled, how it is done, productivity, design factor, and recommendations. *United States Chemical Milling Corp.*

Circle No. 669, Page 7-8

Technical data . . . catalog free. Revised listing of pocket-size books sell-

ing for \$1.25 covering every field of engineering. Partial list includes machine design, metallurgy, conversion tables, mechanics of materials. *Lefax Publishers.*

Circle No. 670, Page 7-8

Wire rope sling . . . news release of interest to any foundrymen buying slings. *Lowery Bros.*

Circle No. 671, Page 7-8

Wood and metal pattern . . . development and production described and illustrated in 12-p booklet. Also gives methods of developing plastic patterns and molds for short run use.

Core box and drier developments for large scale foundry use reviewed. *The Motor Patterns Co.*

Circle No. 672, Page 7-8

Pinholes or inclusions . . . is the title of this newsletter which discusses inspection, causes, inclusions, improperly cleaned ladles and other factors causing these faults. States defects are not all caused by sand. Informative bulletin for foundry practices. *American Colloid Co.*

Circle No. 673, Page 7-8

Aluminum air-ducts . . . guide provides up-to-date and complete data.

SERVING FOUNDRYMEN THE WORLD OVER

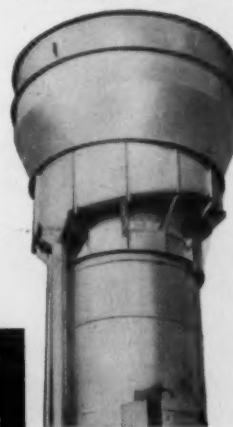
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FOUNDRIES

MULTI-WASH COLLECTOR



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This combination of Schneible Collectors is keeping foundries all over the country dust-free and fume-free for better public and employee relations, while completing schedules smoothly, too.

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Write or wire for details for better foundry operation with Schneible dust controls.

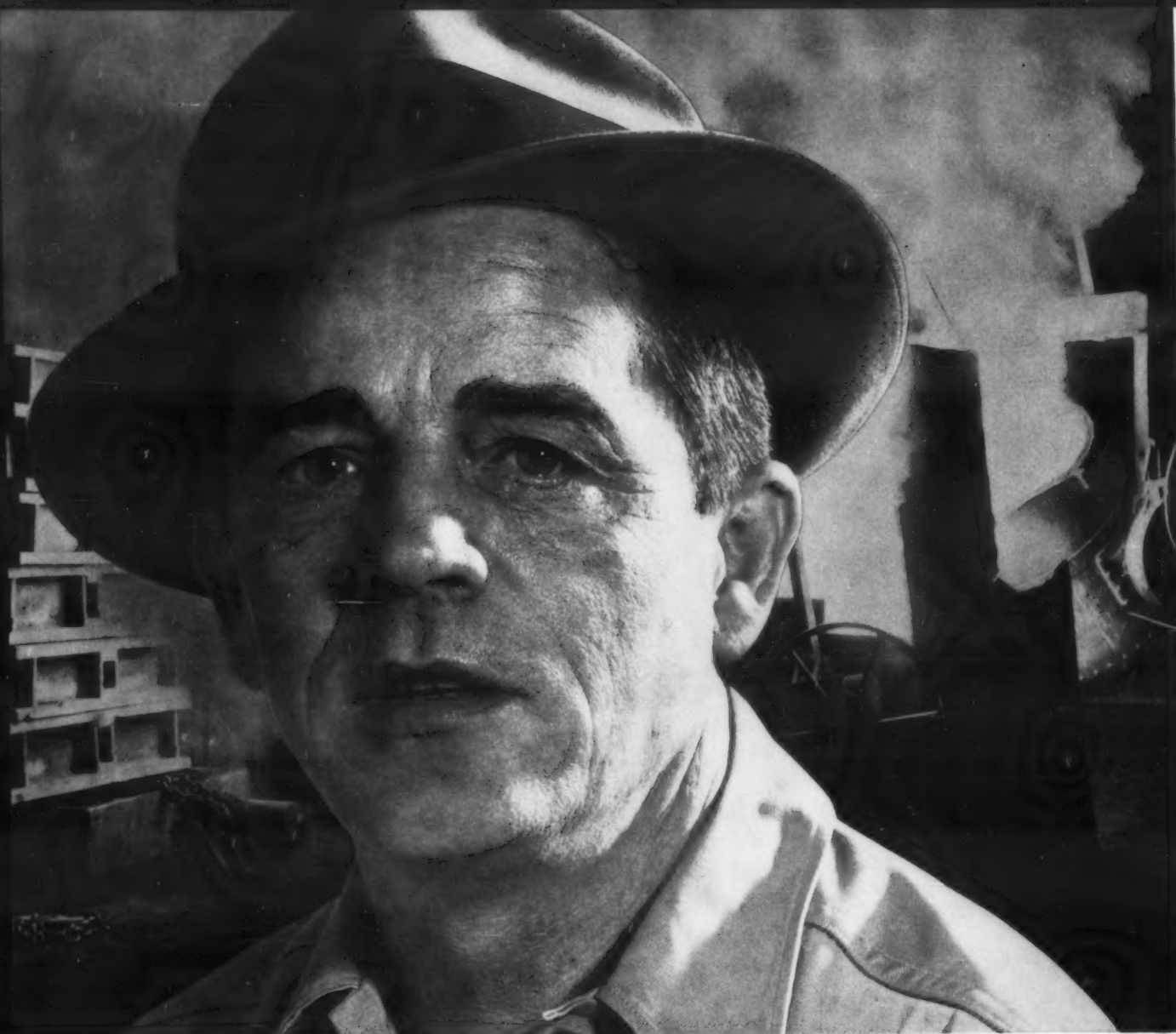
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Circle No. 762, Page 7-8



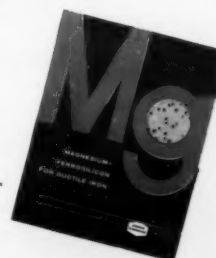
"It's the lowest cost alloy for ductile iron"

Foundries find that ELECTROMET's magnesium-ferrosilicon is an economical, convenient source of magnesium for ductile iron. When added to a suitable composition, the alloy gives maximum ductility by promoting a matrix of soft ferrite. By adjusting the analysis, it can easily be used in high-strength irons having somewhat lower ductility.

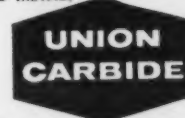
Magnesium-ferrosilicon is available in grades with or without cerium. Cerium (0.5 or 2%) helps control unwanted residual elements which hinder the formation of spheroidal graphite. For further information and technical assistance, contact your ELECTROMET representative.

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Prepared with assistance of top mechanical engineering authorities.

Book contains detailed chapters on engineering, drafting, estimating, fabricating and installing aluminum ductwork. Commercial, industrial and residential applications considered. Ring-bound in hard, aluminum foil cover with 350 illustrations. Sent without charge by circling No. 674 on Reader Service Card, p 7-8. *Reynolds Metal Co.*

Zinc-base alloy . . . design and production data offered in handy pocket guide as a service to die casters and engineers. Contains 24-pp of factual information giving composition, mechanical properties, physical constants and standard commercial, government, ASTM and SAE specifications on alloys. New alloy reputed to have dimensional stability and resistance to corrosion. *Henning Bros. & Smith, Inc.*

Circle No. 675, Page 7-8

Refractory smoke stack . . . for commercial and industrial uses described in 8-p folder. Gives information on centrifugally-cast, low cost, insulated smoke stack of permanent refractory material, said to provide greater draft than steel stack. *Van-Packer Co., Div. of Flintkote Co.*

Circle No. 676, Page 7-8

Pyrometer bulletin . . . includes descriptive and technical data on optical, micro-optical, radiation, immersion, surface, and indicating pyrometers. Models, specifications, price accessories included. *The Pyrometer Instrument Co.*

Circle No. 677, Page 7-8

Load-grab clamp . . . for problems encountered in handling drums, kegs, rolls or other cylindrical loads, boxes, and bales covered in bulletin. Clamp with drum arms, rubber-faced arms, bale, box-grab, roll or pallet arms. Side shift attachment permits load to be shifted from side to side without moving truck. *Hyster Co.*

Circle No. 678, Page 7-8

Resin coated sand . . . guide available on request. Covers trends in production of shell mold castings. Production and application problems encountered summarized from actual reports. *Durez Plastics Div., Hooker Electrochemical Co.*

Circle No. 679, Page 7-8

Chemical treatment . . . of metals described in 8-p brochure. Describes various chemical conversion coatings for steel, aluminum, galvanized iron, zinc and cadmium plated surfaces

Circle No. 763, Page 7-8

for corrosion resistance, paint bonding, drawing and forming, and protection for friction surfaces. Also lists current specification chemicals for Government and its contractors. *American Chemical Paint Co.*

Circle No. 680, Page 7-8

Electropolishing . . . in the metallographic laboratory highlighted in January pocket-size AB Metal Digest. To place your name on mailing list circle No. 681, Reader Service Card, p 7-8. *Buehler Ltd.*

Conveyor belt . . . concise, comprehensive, material designed to serve layman and expert in field of materials handling by conveyor belt. One section devoted to typical applications; another to 6-pp of terminal application tables.

Also terminal dimensions and conveyor selection covering horsepower, types of drives, speeds and loading material; a fourth to conveyor engineering which includes data on idler spacing, conveyor slopes, vertical curves, methods of plotting curves and determination of discharge curve. *The Jeffrey Mfg. Co.*

Circle No. 682, Page 7-8

Dust control systems . . . 36-p catalog gives detailed information on filter and system specifications as well as extensive hopper and support data. Engineering section outlines step-by-step procedure that can be followed in determining type and size of hooding, piping, and dust filter. Tables provided to aid in determining components to meet particular job requirements. *The W. W. Sly Mfg. Co.*

Circle No. 683, Page 7-8

Air powered wheel grinder . . . illustrations and specifications given in new tool bulletin. Three basic models shown as aid in selecting right tool for the foundry job. *Rotor Tool Co.*

Circle No. 684, Page 7-8

Metallographic sample mounting . . . operation by push button control covered in handy pocket-size digest. Self-contained hydraulic system; controlled molding pressure; used for bakelite or transoptic mounts. *Buehler, Ltd.*

Circle No. 685, Page 7-8

Industrial car . . . design and construction brochure. Custom built cars for moving castings in foundry and heat treating department discussed. Shows all types of running gear, with wheel dimensions to suit requirements. Most widely used are chilled, flanged cast-iron wheels, steel

Circle No. 764, Page 7-8

Whatever you pour, there's a **FEDERAL GREEN BOND BENTONITE** tailored for you!

for
**IRON and NON-
FERROUS CASTINGS**
specify **L-J***
GREEN BOND
(*Low-Gelatinating)

The highest grade, pure Western Bentonite ideal for bonding regular synthetic sand systems containing fines, cereals, and residual clay. The L-J characteristic makes it possible to attain high green and dry compression strength with the addition of a minimum quantity of water. **FEDERAL GREEN BOND L-J** permits a thinner slurry and faster mulling; reduces the strain on pumps when used in a slurry system.

The "Best of the Bentonites" for 32 years, old reliable **GREEN BOND** is absolutely uniform, unadulterated and free from chemicals.

Send for L-J TEST SAMPLE

Archer-Daniels-Midland Company
Federal Foundry Supply Div.
2191 West 110th Street
Cleveland 2, Ohio

Will you please have your Technical Representative arrange for a test of **GREEN BOND BENTONITE L-J** in our foundry.

NAME _____

TITLE _____

COMPANY _____

ADDRESS _____

CITY _____ ZONE _____

STATE _____



for
STEEL CASTINGS
specify **H-J***
GREEN BOND
(*High-Gelatinating)

GREEN BOND H-J means high gelatinating, and is mined exclusively for steel foundries where new or reclaimed sands are used. New sands, having no organics, fines, or residual clays to retain moisture, require the addition of high-gelatinating Bentonite for moisture retention.

FEDERAL GREEN BOND H-J absorbs and retains water better in such sands than any Bentonite you can use. This material completely meets steel foundries' requirements.

GREEN BOND H-J may be furnished either granular or pulverized to conform to various mulling and air conditioning systems.

Send for H-J TEST SAMPLE

Archer-Daniels-Midland Company
Federal Foundry Supply Div.
2191 West 110th Street
Cleveland 2, Ohio

Will you please have your Technical Representative arrange for a test of **GREEN BOND BENTONITE H-J** in our foundry.

NAME _____

TITLE _____

COMPANY _____

ADDRESS _____

CITY _____ ZONE _____

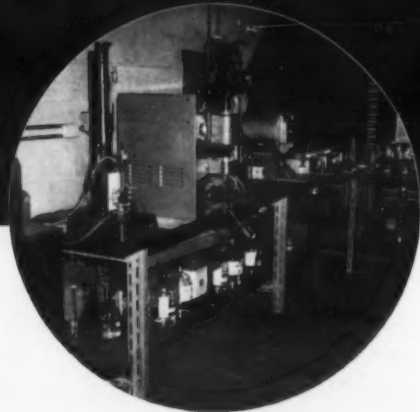
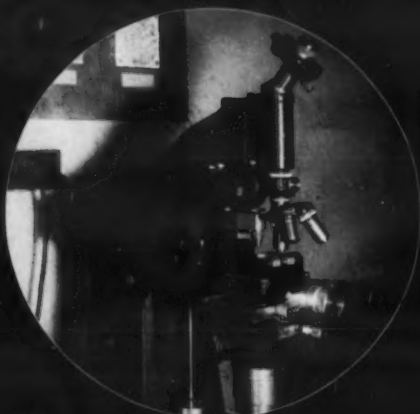
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FEDERAL FOUNDRY SUPPLY DIVISION

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a fine
laboratory
guarantees
a fine
product

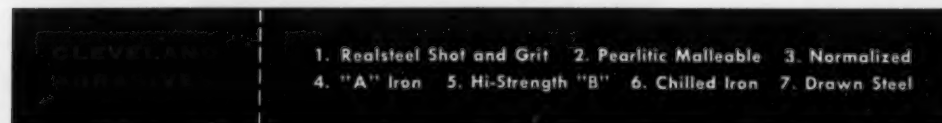
We have placed a lot of earnest dollars on the line to develop outstanding laboratory facilities. This investment has been deliberate, because we have a reputation for top-quality, uniform metallic abrasives, and we want to maintain it!

Out of these facilities have come consistently rigid production standards which meet our own, as well as SAE, specifications. Also out of these facilities have come our two latest *new* products . . . "A" shot and grit, a controlled analysis chilled iron having extremely long life; and *Pearlitic Malleable* shot and grit.

These two new metallic abrasives, combined with our regular line of *Persuasive Abrasives*, give you a complete range and availability of product to fit your cleaning or peening requirements.

Paletized, banded, covered . . . any way you wish.

Write for our catalog or call in our nearest representative to discuss the Cleveland line further.



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Circle No. 765, Page 7-8

with flat steel tires, pneumatic tires, and tires of resinoid or other special purpose compositions. All integrated parts shown for furnace cars, platform cars, cross-bay transfer cars, and other motorized cars. *Easton Car & Construction Co.*

Circle No. 686, Page 7-8

LP gas . . . for industrial trucks highlighted in house organ. Features comparison table of truck operating costs using gas, gasoline and batteries. Figures based on annual and hourly costs of operation and arranged to tell causes of many operating deficiencies, plus suggested remedies. *The Elwell-Parker Co.*

Circle No. 687, Page 7-8

Induction heating . . . review available. Contains many interesting applications, articles and shop hints on high frequency induction heating. Includes table on induction heat treatment of cast irons and other factual information. *Lepel High Frequency Laboratories, Inc.*

Circle No. 688, Page 7-8

American Welding Society . . . announces formation of committee to review recently prepared arc welding manual. Training material is to supply industry and vocational training centers with factual, authoritative information. Written expressly for welders, data is basic and direct. Further information concerning material can be obtained. *American Welding Society.*

Circle No. 689, Page 7-8

Finishing systems . . . brochure discusses cleaning, painting and baking. States well designed system consists of integrated pieces of equipment engineered to obtain quality finishing. Should reduce fuel, power, space and labor costs and improve product quality. All types of washers, ovens, spray booths, phosphatizing units discussed. *Schmiege Industries Inc.*

Circle No. 690, Page 7-8

Fork lift . . . low lift pallet, and low lift platform worksavers presented in interesting cutaway brochure. Sectionalized views and a system of unique die-cut pages used. Pictorially disassembles to point out all operating features of worksavers. *The Yale & Towne Mfg. Co.*

Circle No. 691, Page 7-8

Water-soluble resin . . . is revolutionary new product for foundries. Half-ounce of resin Polyox in pint of water thickens to ropy consistency, valuable in adhesive applications. Other features: complete solubility at low concentrations; high thickening efficiency in dilute solution; low atmosphere

pick-up in dry form; can be calendered, molded, extruded or cast. *Union Carbide Chemicals Co., Div. Union Carbide Corp.*

Circle No. 692, Page 7-8

CO₂ process products . . . technical bulletin. Lists six products adapted to the CO₂ process for making cores and molds—sand conditioner, liquid core paste, mudding compound, Kast Kleen Kompound, binder, and two coatings for cores and molds. *Frederic B. Stevens Inc.*

Circle No. 693, Page 7-8

High vacuum . . . components, equipment, and systems, 16-p product summary and price list. Described as the most comprehensive listing of laboratory and industrial vacuum facilities available today. Includes all types of mechanical and diffusion pumps, gauges, valves and accessories such as connectors, switches, and feed-troughs. *NRC Equipment Corp.*

Circle No. 694, Page 7-8

Thermometers . . . indicating, recording and controlling, 60-p catalog aids in selection of indicator or recorder. Technical data indexed giving selection; thermal systems; pneumatic control; pneumatic transmission; electric control; duplex-dual control; program control; combinations; special purpose; charts and scales; specifications and ordering information. *Minneapolis Honeywell Regulator Co.*

Circle No. 695, Page 7-8

Pyrometer . . . catalog supplies information from theory and practice to specific charts and inks. Contents also cover general thermocouple information, base metal, small mass, sensitive thermocouples, noble metal, special purpose, mounting attachments, components. *Minneapolis-Honeywell Regulator Co.*

Circle No. 696, Page 7-8

Water-cooled cupolas . . . technically discussed showing diagrams of water-cooled cupola designed around the turn of the century through modern cupola which features heavy plate and independently supported upper stack. Discusses primary purpose of water jackets and high rate of thermal efficiency in cupolas with gradual erosion of lining. *Whiting Corp.*

Circle No. 697, Page 7-8

Operator's guide . . . for lift trucks has helpful data on handling and stacking techniques; construction, operation, and maintenance. Of special interest to owners and operators, this pocket-size manual contains valuable safety tips and popular accessories.

Continued on page 145

See it
at the Shew*

CORELESS 60 CYCLE INDUCTION MELTING FURNACE

*AFS FOUNDRY SHOW
Cleveland, May 19-23
BOOTH NO. 1306

IF YOU ARE
UNABLE TO
ATTEND THE SHOW
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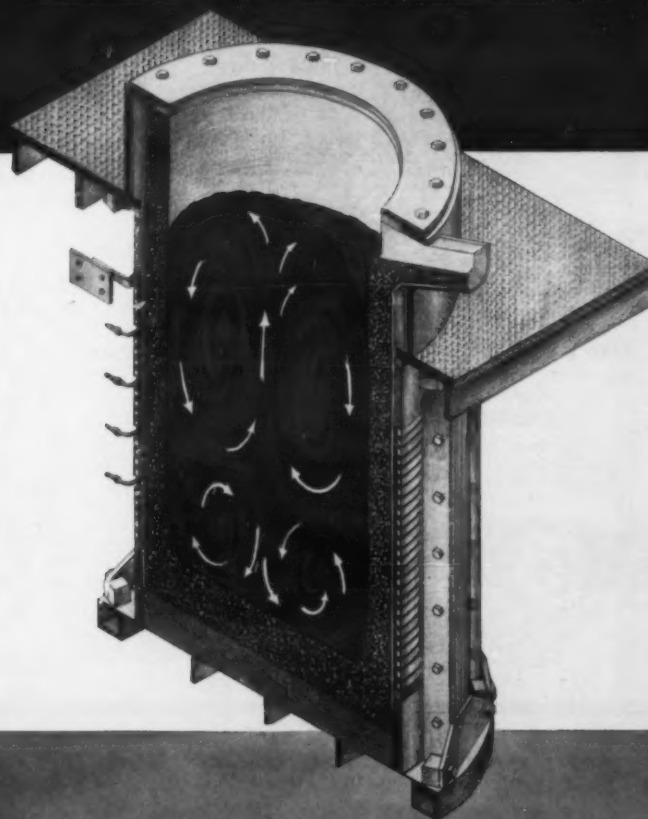


60 CYCLE INDUCTION MELTING ENGINEERING CORPORATION TRENTON 7, NEW JERSEY

Associated Companies: Ajax Electrothermic Corporation Ajax Electric Company

Circle No. 766, Page 7-8

AJAX-JUNKER



A cylindrical induction coil supplied with ordinary 60 cycle current induces heat and vigorous electromagnetic stirring in the molten metal charge. Integrated electric controls regulate power, maintain high power factor automatically. Monolithic refractory linings are made by ramming against the sturdy water-cooled coil held in a rigid frame of magnetic and structural steel.

This new principle was perfected in Europe over the last seven years. Over 100 Junker furnaces are now in use. AJAX-JUNKER designs are based on latest experience, using American components and practices throughout.

Outstanding results are proven in these fields:

DUCTILE AND ALLOY IRON CASTINGS
RECOVERY OF IRON TURNINGS
RECOVERY OF ALUMINUM SCRAP

Available sizes range from 1 to 10 tons, with normal melting cycles from 2 to 4 hours. Power ratings are 200 kw through 1500 kw.

We'll be expecting you . . .

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Discuss your specific foundry coke problems with our friendly staff.

See the range of coke sizes available to you.

Take a color film trip through our coke making operation.

AMERICAN FOUNDRYMEN'S SOCIETY

62nd. Annual Castings Congress and Foundry Show
Cleveland Public Auditorium
May 19 to 23, 1958



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Semet-Solvay Company, Ltd., Toronto

Circle No. 767, Page 7-8

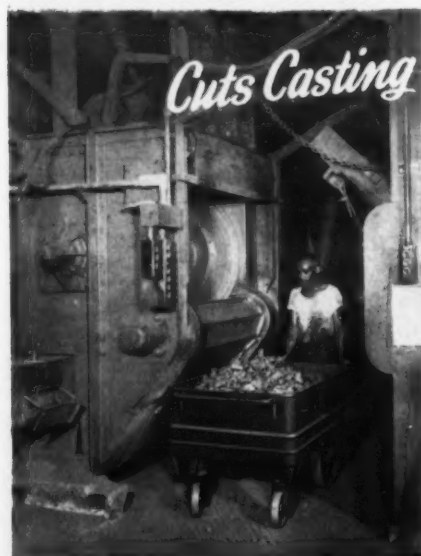


Illustration shows one of 25 Sterling Heavy Duty Trucks in daily use at the Green Foundry, St. Louis, Mo.

Sterling

FOUNDRY EQUIPMENT

Circle No. 768, Page 7-8

144 • modern castings



dietrich's corner

by h. f. dietrich



Clean Up the Shop

What's wrong with being a foundryman? Whenever I mention in mixed company that I worked in a foundry, some needlenosed, bifocaled biddy squints down her beak and makes a noise like she's blown a gasket. After that she prances around me at a safe distance.

I'll admit I have spent some time in foundries that would make a rat hole look like the Shamrock-Hilton. But that wasn't the fault of the foundry. The foundry can't be cleaner than management makes it.

Left to himself, man is the most untidy animal. He—or she—will leave anything where he drops it. An animal in the wild will carefully avoid cluttering a trail. It is his means of escape. An accident on a cluttered trail means certain death. Man will fill a gangway. He will not clean up more space than he requires to stand erect. We find potential traps in such things as overfilled closets, and castings piled all over a foundry or cleaning room floor.

Because of man's propensity toward being a litterbug, many foundries in the past became dismal, smelly, dirty rat holes. There are just too many items used in a foundry that lend themselves to contributing toward a general mess. This mess gave foundries a bad name that is still used as a generalization.

I think the first improvement made in the foundry was the airtight building. Management learned that a molder could produce more molds if he didn't have to cut two inches of frozen sand off of the heap before he started to work. To conserve heat it was necessary to close off all openings along the edges of the building.

Heated buildings allowed the molder to work without gloves and a sheepskin coat, but it presented a problem during the heat. Seated in their own warm cubicles, conservative, misguided managers reasoned that hot metal running in the foundry

should supply enough heat. They would shut off the steam just before pouring time. Steam from poured molds condensed in the air cooled by windows and outside walls. The result was a fog on the pouring floor that reduced visibility to zero. Molders staggering through the fog showed all symptoms of drowning.

Some of the early attempts at cleaning up in the foundry ended in humorous errors. For instance large exhaust fans were installed in the main bay of a small foundry in the midwest. They had been having a smoke problem because of the use of core molds. In fact, a man without a compass could become lost in the main bay until two hours after the bottom dropped. To clear the air, the fans were installed in the ends of the arched roof and management bragged that the air in the bay would be changed every two minutes.

During the last part of the summer the fans did an excellent job. The floors could be poured without the aid of a seeing-eye dog. But the first cold days of winter created a new problem. During the day when molds were being made everybody got along fine. Molders working in a warm, well lighted building produced satisfactory floors; coremakers filled the racks and put them in night ovens to bake; the heat whistle blew; the fans were turned on; and the trouble started. The fans caused a vacuum in the building that drew in cold air in every crack. If the windows were opened, cold air rushing in would condense the steam coming from the molds. If they weren't opened, core gas would be drawn down the stacks into the main bay.

If your foundry is a mess of scattered junk; if a man can't find his way from one end of your foundry to the other during pouring time; Brother, you're behind the times. You are helping create a bad name for foundries in general and driving young men away from the industry. Clean up the place.



PQ specializes in soluble silicates and can serve your specifications for either dry or liquid silicates. Please be assured that private formulations will be held in strictest confidence. Let's discuss your silicate needs.



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Circle No. 769, Page 7-8

M. HOLTZMAN METAL CO.

SMELTERS AND REFINERS
SINCE 1900

HOLMCO

**GUARANTEED Brass, Bronze and
ALUMINUM INGOT to your specifica-
tions IMPROVED WITH FACTOR "X"!**

Send us a sample order! If you want to improve the quality of your finished products at no additional cost... let us show you what HOLMCO ingot, improved with Factor "X" can mean to you!

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CHestnut 1-3820

Circle No. 770, Page 7-8

For the Asking

Continued from page 143

Conveniently indexed for ready reference and aimed at improving driver efficiency. *Towmotor Corp.*

Circle No. 698, Page 7-8

Magnetic particle inspection kit... powered by any 115 V outlet or storage battery described in type Y-5 Magnaflux Yoke kit. Description of contents, technique and operation given. *Magnaflux Corp.*

Circle No. 699, Page 7-8

Melting furnaces... for brass, bronze, aluminum, and other non-ferrous metals covered in new brochure. Data describes, in detail, furnaces which are gas and oil fired; also mechanical and hydraulic tilt, and crucible. *Stroman Furnace & Engineering Co.*

Circle No. 700, Page 7-8

Continuous mixing diagram... shows inexpensive process of properly conditioning green sand with emphasis on dry premixing and uniform sand properties. *Pekay Machine & Engineering Co.*

Circle No. 701, Page 7-8

Core and mold ovens... bulletin discusses construction, and efficiency of heat treating furnaces, core and mold ovens, hi-speed rod bakers. Comparison charts, case histories, schematic drawings given. *The Carl Mayer Corp.*

Circle No. 702, Page 7-8

Industrial gas equipment... catalog shows latest data tables and work rate charts. Describes industrial gas burners, furnaces and accessories for heat treating, metal melting, soldering and drying. Includes sections on manual and automatic controls. Highly accurate dimensional and Btu performance tables included. *Charles A. Hones, Inc.*

Circle No. 703, Page 7-8

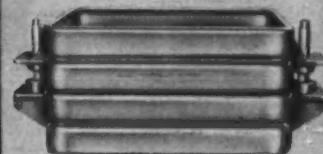
Handy calculator... for grinding room tells at a glance just how much grinding concentrate to add to a tank for a desired mixing proportion. Figured in pints, quarts and gallons; covers tanks with capacities ranging from 10 to 150 gal. Also translates grinding wheel diameters and rpm into surface speeds in ft per min. Grinding wheel marking system chart appears on back. Available on Reader Service Card, circle No. 704, p 7-8. *The White & Bagley Co.*

Vibrating... bulk materials handling equipment catalog has 60-pp of product illustrations, descriptions and specifications. Products listed include vibrators, packers and jolters, car

GREATER STRENGTH-INSIDE



FP 16-9C



FP 16-C

by *American* of course

Added strength and rigidity of these flasks by American lies in the inside corrugation. American **INSIDE STRENGTH** of the $\frac{1}{4}$ " walls actually assures more rigidity than other type reinforcements, more resistance to squeeze of air pressure. Inside corrugation of the walls assist in holding sand—makes for easier shake out, and means that the flasks will maintain their shape and pincenters—give better, longer service.

★ Sturdy, durable streamlined design
★ Low Maintenance Cost ★ Easier to Handle

The number of inside corrugations is determined by depth of sections. For extreme pressure, sections may also be furnished with American's special channel welded reinforcement.

AFFCO superior flasks are the result of over 25 years research and best possible workmanship. Write for our new, complete Flask Catalog, and visit our booth #813 at the Foundry Show and Convention in Cleveland in May.

Our facilities assure you of prompt fabrication and quick shipment of your orders.

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Division of Cramb & Gogel, Inc.

**AMERICAN
FOUNDRY
FLASK
COMPANY**
2748 SOUTHWEST BLVD.,
KANSAS CITY 8, MO.

Circle No. 771, Page 7-8

**"Samson"
Shot**



**"Angular"
Grit**

better chilled iron abrasives ...and why

We have specialized in the manufacture of metal abrasives since 1888. We have "grown up" with their expanding use. Such long contact with their production and use has given us unequalled know-how and experience in their manufacture.

A continuous program of research for the improvement of metal abrasives has been carried on with one of America's foremost metals research organizations since 1937.

We employ the most modern techniques in melting and processing to produce metal abrasives to exacting standards of chemistry, hardness, toughness and uniformity of these elements from one lot to another. It is more than significant that the two largest manufacturers of blast-cleaning equipment in the world sell and recommend Samson Shot and Angular Grit for best results in their equipment.

**MALLEABRASIVE
Shot and Grit**



**TRU-STEEL
Shot**

**LEADERS in development of
PREMIUM-TYPE ABRASIVES**

The two best known names in premium abrasives were developments of two of our subsidiaries. MALLEABRASIVE, the first malleablized type of metal abrasive ever produced, set the pace for development of all other makes of premium abrasives. TRU-STEEL Shot was the first high-carbon all steel shot produced to meet demand for this specialized type of abrasive.

One of these products may do your blast-cleaning job better, and at lower cost. Write us for full information.

PITTSBURGH CRUSHED STEEL CO.

Arsenal Sta., Pittsburgh 1, Pa.

Subsidiaries: - - -

The Globe Steel Abrasive Co., Mansfield, O. (Malleabrasive)
Steel Shot Producers, Inc., Arsenal Sta., Pittsburgh (Tru-Steel)

Circle No. 772, Page 7-8

rappers, hopper level switches, flow control valves, feeders, and other pertinent materials. *Syntron Co.*

Circle No. 705, Page 7-8

free films

■ Motion pictures and other visual aids based on foundry processes and supplies are also yours for the asking. These films are suggested for formal or informal training groups. The owners of films in this column will send booking request forms to MODERN CASTINGS readers who circle the appropriate number on the Reader Service card (page 7-8).

Milling and Smelting . . . 54 min, 16mm, sound and color film. Briefly describes huge smelter where riddle of the rock is being solved—evolution, separation of minerals, technique in preparation, processing recovery of other minerals. *The International Nickel Co.*

Circle No. 706, Page 7-8

Modern Methods for Joining Metals . . . 20 min sound, color film. Available for showing at plant, society or group meetings. Film shows a variety of welding processes and applications and is treated in a non-technical manner. *Linde Air Products Co., Div. of Union Carbide Corp.*

Circle No. 707, Page 7-8

Johnson Wax Film . . . color, sound, 16-min demonstrates the importance of being a floor specialist—the techniques of maintenance and use of products. *S. C. Johnson & Son, Inc.*

Circle No. 708, Page 7-8

Meehanite Castings for Pressure Tightness . . . 16mm sound film and four 35mm sound slide films. Explains the significance of the modulus of elasticity and its effect on metal. Importance of design is stressed and examples provided. *Meehanite Metal Corp.*

Circle No. 709, Page 7-8

Modern Material Handling Methods . . . 16mm sound film. Discusses present day improvements on moving materials. *Clark Motion Picture Films.*

Circle No. 710, Page 7-8

Automation in the Metallurgical Laboratory . . . 16mm sound and color film, 30 min. Scientific presentation of correct sample preparation techniques in metallography. Offered for men now associated or about to become associated with metallurgy. For professional groups. *Buehler Ltd.*

Circle No. 711, Page 7-8

Induction Heating . . . 15 min, 16mm, color, sound film. Portrays the modern induction heater in action; shows application in hardening, annealing, brazing and soldering. *Allis-Chalmers Mfg. Co.*

Circle No. 712, Page 7-8

**MEASURE
HEAT
ACCURATELY**
with

the improved

**PYRO
OPTICAL
PYROMETER**

The only self-contained direct-reading optical pyrometer for quick temperature measurements of molten iron, steel, monel, etc.

Send for catalog No. 85.



the improved

**PYRO
SURFACE
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Rugged, easy to read. Ideal for shell molding, core oven, mold and die surface temperature measurements.

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**PYROMETER INSTRUMENT
CO., INC.**

BERGENFIELD 10, NEW JERSEY

Circle No. 773, Page 7-8

MORE TECHNICAL TALKS

on tape

■ Tape recorded talks on 21 important facets of metalcasting technology are now available for sale. These 21 subjects have been selected by the editors of MODERN CASTINGS and are recommended as training aids for in-plant programs, for individual study, and for gatherings of technically-intent foundrymen.

All talks were recorded at National, Chapter and Regional meetings of the American Foundrymen's Society. Each presentation is complete, including the question and answer period. Any conventional tape recorder may be used.

Titles of the recordings and their sale prices follow. An order form is on the next page.

A Review of Steel Foundry Literature from Behind the Iron Curtain (40 min)

by A. J. Kiesler \$4.25

Austenitic Manganese Steel Technology in Australia (40 min)

by H. E. Cragin, Jr. \$4.25

Practical Studies of Veining Tendencies (52 min)

by George DiSylvestro \$4.75

Effect of Various Clays and of Tempering Methods on Sand Properties and Casting Quality (52 min)

by A. E. Murton \$4.75

Mold Hardness: What It Means! (45 min)

by E. H. King and J. S. Schumacher \$4.50

Influence of Sand Grain Distribution on Green Sand Casting Finish (70 min)

by C. E. McQuiston ... \$7.00

European Self-Curing Oil Binders (45 min)

by Dr. Franz Moser ... \$4.50

Some Generalized Solidification Studies (40 min)

by V. Paschkis and J. W. Hlinka \$4.25

Temperature Drop in Pouring Laddles (90 min)

by V. Paschkis and J. W. Hlinka \$7.50

modern castings

FOUNDRY FACTS NOTEBOOK

Metallurgy of Gray Cast Iron

Part 2: Phase Transformations During Cooling

FOUNDRY FACTS NOTEBOOK is designed to bring you practical down-to-earth information about a variety of basic foundry operations. As the name implies, this page is prepared for easy removal and insertion into a notebook for handy future reference.—Editor.

By C. H. MORRIS
Vice-President & Works Manager
The Kennedy Valve Mfg. Co.
Elmira, N.Y.

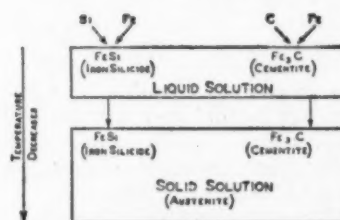
● To simplify understanding of phase transformations in gray cast iron, the effects of sulphur, phosphorous and manganese will be ignored. Cast iron then becomes an alloy of iron, carbon, and silicon. Carbon and silicon are both soluble in iron. They combine with iron to form chemical compounds shown in Diagram 1. The compounds of iron and silicon and of iron and carbon are shown to be soluble in molten or liquid iron.

A solution is a homogeneous mixture of two or more substances. Homogeneous means that any portion of the mixture is exactly like every other portion. When common salt

simultaneously be dissolved in molten iron, as shown in Diagram 1. However, in the salt-water solution, if cooled far enough, all the salt can be frozen out and the ice formed will be pure water.

In the solution of iron-silicon-carbon, something different happens on cooling. When the iron freezes, substantial amounts of carbon and silicon remain in solution in the solid metal. This is called a "solid solution", and it answers

DIAGRAM 2



perfectly the requisites of a solution, because it is homogeneous. This state is represented by Diagram 2.

Austenite, the metallurgical term for this solid solution, is rather soft and ductile but very strong and tough. It has the somewhat unusual property of work hardening, which makes it difficult to handle in rolling, forging, and machining operations. It is the constituent that gives manganese steel its distinct properties. Other examples of austenitic metals in practical use are 18-8 stainless steel and NiResist cast iron.

Only when alloy content is high can austenite exist at room temperature. The above examples are all highly alloyed; they are all normally nonmagnetic—a characteristic of austenite. If the cast iron is not of high alloy content, the solid solution of carbon (austenite) will not continue to exist below a certain temperature.

As it cools below that temperature it breaks down, much as the salt-water solution did, and iron

carbide separates out. This is the iron carbide, called cementite, that forms "hard spots" in cast iron. It is extremely hard and brittle, assumes irregular shapes, and is likely to be spread around in no definite pattern.

If there were no silicon in this iron-carbon system, these carbides would continue to exist as carbides in some form. If reheated, the carbides would go back into solution. Even though slowly cooled back down to room temperature, the same amount of carbides would be present as formerly. If cooled quickly, such as by quenching, the size and shape of the carbide particles could be changed but the quantity would still be the same.

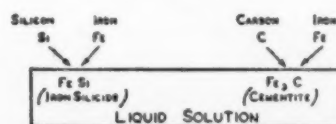
The presence of silicon in the iron, however, has the faculty of causing the iron carbide (cementite) to break down into the iron and carbon from which it was formed. The carbon now comes out as graphite. The quantity that emerges will be dependent upon the amount of silicon present, as well as upon time and temperature. The reaction takes place fastest at high temperature, so the longer the system remains at high temperature the more graphitic carbon will be formed for any given silicon content. The system can now be represented by Diagram 3.

The graphitic carbon that separates out at this point is relatively coarse and in rather large flakes or in irregularly shaped patches. It forms most rapidly just below the freezing point (1900 to 2000 F). The metal is still plastic at this temperature permitting the graphite flakes to grow rapidly with little restriction. This graphite is called "primary graphite" because it forms from the first decomposition of cementite that takes place.

As the metal temperature drops, the solubility of the iron carbide in austenite decreases. The carbide is rejected from solution and is then decomposed by the influence of the silicon. As the iron cools graphite continues to form, but more and more slowly.

When the temperature drops

DIAGRAM 1



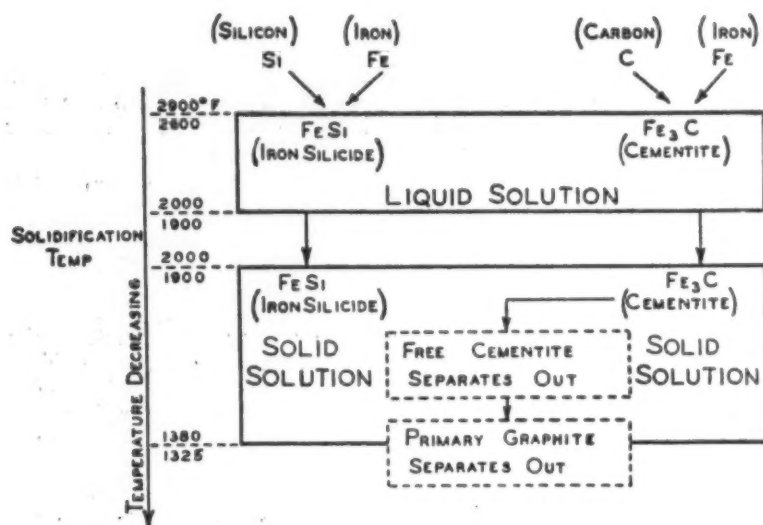
is dissolved in water a true solution exists. It is homogeneous; that is, every spoonful of the substance is exactly like every other spoonful and contains exactly as much salt. Up to a limit, the amount of substance that can be dissolved in water will increase as the water is heated.

Contrariwise, if all the salt is dissolved in hot water that the water will hold and then the solution starts to cool, some salt will separate out because the solubility decreases with decreasing temperature.

Similarly, carbon and silicon can

Metallurgy of Gray Cast Iron

DIAGRAM 3



sufficiently, the iron then reaches a point known as the critical temperature. It is called "critical" because something of major importance occurs there. In the case of cast iron it is simply the temperature at which the solid solution (austenite) ceases to exist. This temperature varies with composition and is somewhere in the range of 1325 to 1380 F. For ordinary cast iron it is about 1350 F.

Now a new constituent appears. The solid solution austenite which had remained after the rejection of iron carbide now is converted to "pearlite". This stage is represented with Diagram 4.

If a low silicon iron was poured into a light casting which cooled rapidly the finished structure of that casting would be as shown in Diagram 4. In fact, if this small casting cooled fast enough to prevent formation of primary graphite, the structure would show nothing but pearlite and cementite. Such is the case when white iron is made. In fracture, such iron appears grayish to silvery white, with no spots of graphite showing.

A somewhat larger casting, if poured from the same iron, would cool more slowly, permitting some primary graphite to form. In fracture, this iron would appear mottled, with some splotches of graph-

ite showing in the steely, gray-white fracture. A still larger casting could, at this stage, appear gray in fracture, there being enough graphite present to make it appear so.

The new constituent, pearlite, is

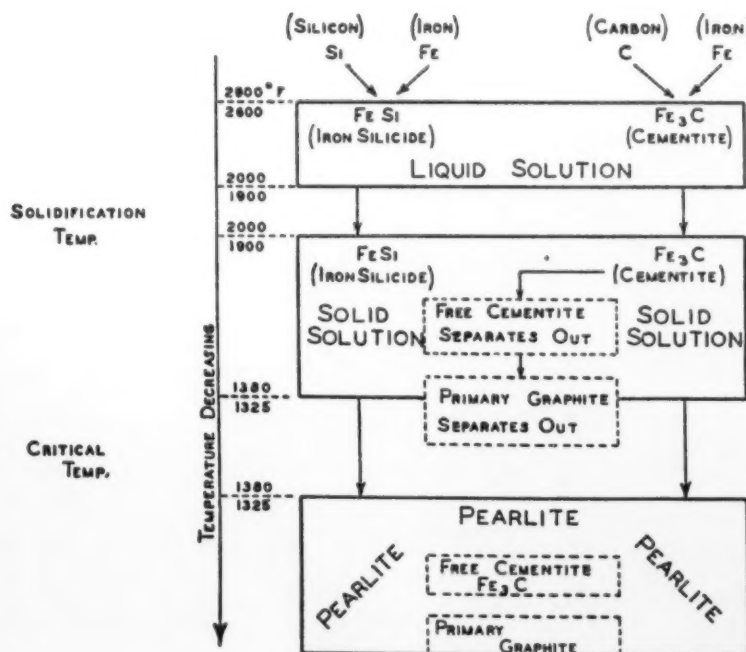
so named because of its gray, pearly luster. It is strong, about 120,000 psi tensile strength; ductile and tough; and moderately hard—about 225 Bhn. Sandwich-fashion, it is made up of alternate layers of cementite and ferrite. Ferrite is the name for iron that is free of carbon. In this instance ferrite is a solid solution of silicon in iron.

Alternate layers of ferrite and cementite, as they exist in pearlite, are so thin that they exhibit little of their own characteristics, and the laminated arrangement acts much as a separate metal. Since the machinability of pearlite is excellent, its strength-giving ability renders it a very desirable constituent in iron castings.

The amount of iron carbide contained in pearlite will vary with the silicon content. Starting at 0.80 per cent carbon at 0 per cent silicon, the carbon content of pearlite will be reduced about 0.07 per cent for every per cent of silicon present.

Presented at Clinic sponsored by Metallurgical Associates, Inc. New York.

DIAGRAM 4



Brass and Bronze—Castings Design Clinic (45 min)

Panel: F. L. Riddell, "Gating"; G. F. Watson and R. A. Colton, "Design of Castings." . . . \$4.50

Properties of Molding Sands under Conditions of Gradient Heating (55 min)

by N. C. Howells, R. E. Morey and H. F. Bishop . . . \$5.00

Influence of Various Bonding Materials on Stress-Strain Characteristics of Bonded Sands (32 min)

by F. C. Quigley, P. J. Ahern and J. F. Wallace . . . \$3.50

Oil-Bonded Molding Sand (30 min)

by K. A. Miericke and R. C. Megaw . . . \$3.50

Transport of Feed Metal during Solidification of Tapered Steel Bars (38 min)

by E. J. Sullivan, C. M. Adams and H. F. Taylor . . . \$4.25

Flow of Heat from Sand Castings by Conduction, Radiation and Convection (68 min)

by C. M. Adams and H. F. Taylor . . . \$7.25

Effect of Temperature on the pH of Foundry Sands (30 min)

by N. D. Brinkmann and G. Gottschalk . . . \$3.50

Correlation Between Casting Surface and Hot Properties of Molding Sands (45 min)

Report of AFS Committee 8-J . . . \$4.50

Gating to Control Pouring and Its Effect on Castings (52 min)

by Charles E. Drury . . . \$4.75

Modern Molding Methods—Shell Molding, Educational Short Course (100 min)

Presented at Central Michigan Chapter . . . \$10.50

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by R. H. Dobbins, C. R. Baker, R. H. Behling and D. M. Murray . . . \$10.50

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obituaries

George F. Pettinos, Sr., 96, president, George F. Pettinos, Inc., Philadelphia, and a founder of the American foundrymen's Association, died Feb. 23. Up to the time of his death, he had been active president of the company which he founded in 1892 to supply industry with sand and graphite products.

A delegate to the 1896 convention marking the organization of AFA, Pettinos has been associated with AFS since that time.

He was born in San Francisco and graduated from Lehigh University as a mechanical engineer in 1887, taking a job as laborer for Bethlehem Iron Works, Bethlehem, Pa., predecessor of Bethlehem Steel Corp. While serving as chief engineer for that firm, Pettinos designed the first open hearth furnace. Many of his designs of forge presses, pulverizers, and sand and foundry processing equipment have become standard in industry.

The son of a music teacher, Pettinos was a founder of the Bach Choir in Bethlehem, and for many years held the first violin chair in the Bethlehem Symphony Orchestra.

Charles C. Chambers, 69, president and general manager, Texas Foundries, Inc., Lufkin, Texas, died March 16. He was a member of the AFS Texas Chapter, and Alumni Dinner Speaker at the 1955 Castings Congress held in Houston, Texas.

Chambers was Colonel and Chief of Staff, 37th Div., Ohio National Guard, 1920-1923; and received, among other citations, the Disting-



C. C. Chambers

quished Service Cross while serving in World War I. He was Colonel, War Dept. General Staff, in 1922.

He has been with Texas Foundries, Inc., since his appointment as execu-

tive vice-president in 1938, and president and general manager of the firm since 1939.

Walter A. Russell, 58, general superintendent, Benton Harbor Malleable Industries, Benton Harbor, Mich., died Jan. 28. He was a member, AFS Michiana Chapter.

Prof. Ovid W. Eshbach, 64, the first dean of Northwestern University's technological institute, Evanston, Ill., died March 4. He joined the university shortly before the institute opened in 1939, and served as dean until 1953 when he resigned to devote full time to teaching. He again took over duties as dean for two years in 1955, and was currently the Walter P. Murphy professor of science engineering at the institute.

Charles T. Govier, Assistant secretary-treasurer, The Canadian Furnace Co. Ltd., Port Colborne, Ontario, Canada, died recently. Govier held a membership in the AFS Ontario Chapter.

Stanley Sitarz, president, Prospect Foundry, Minneapolis, and a member of the AFS Twin City Chapter died recently.

W. J. Bach, president, Foundry Service Co., Birmingham, Ala., and a member, AFS Birmingham District Chapter, died recently.

Grant G. Brucker, 56, superintendent, Ideal Foundry, Milan, Mich., died Feb. 13.

James W. King, secretary-treasurer, Rudisill Foundry Co., Anniston, Ala., died Jan. 28.

H. S. Hunt, product superintendent, U. S. Pipe & Foundry Co., Birmingham, Ala., died recently. He was a member, AFS Birmingham District Chapter.

William F. Little, Little Foundries, Inc., Port Huron, Mich., and founder in 1908 of the original company, Little Brothers, died Feb. 9.

E. R. Lamhofer, purchasing agent, Erie Malleable Iron Co., died Feb. 20.

R. H. Hoffman, 43, president of the Robert W. Hoffman Co., Chicago, died March 11. He was a member of the AFS Chicago Chapter, a former county deputy sheriff, and a member of the Cary, Ill. fire department.

D. W. Leedy, 53, foundry manager, Dalton Foundries, Inc., Warsaw, Ind., died recently.

BRAG

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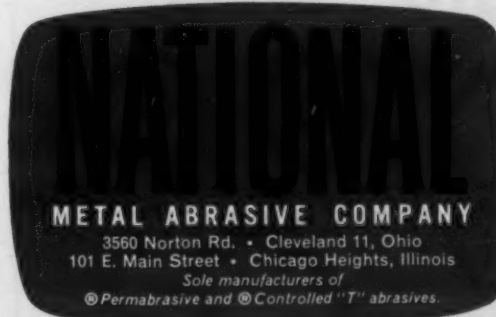
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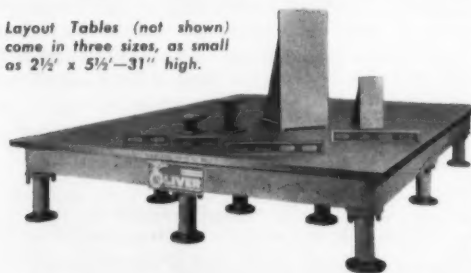


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Circle No. 775, Page 7-8

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Circle No. 776, Page 7-8

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Circle No. 777, Page 7-8

150 • modern castings



questions and answers

Misery loves company so why not share your castings problems with us? Modern Castings invites you to stump the experts with tales of gremlins that are haunting your scrap piles. If any of you readers have better answers to the questions below, write the editor.

Q. Just about the time I have learned the identification of aluminum alloys 45, 95, 356, and 40E then they spring a new one on me. What now is 42B? —R.E.S.

A. Alloy 42B is an aluminum alloy developed by the North American Aviation Co. with good castability and a sand cast tensile strength of 42,000 psi. The alloy is similar to type 356 with low iron content and contains a small amount of beryllium. It is finding increased usage in the aircraft industry. Just to confuse matters a little worse, 42B has recently had its name changed to Tens-50!



Q. We have several salesmen trying to convince us that their dextrine binder is the best on the market for the money. We would like to believe them all but wonder if there is some way to compare dextrines in a fair test?—T.R.G.

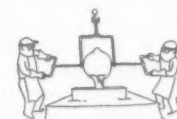
A. The best dextrines exhibit 100 per cent solubility in water. The lower the solubility, usually the lower the price and quality. The general quality of dextrine can also be indicated by its baked shear strength when mixed with sand and tested according to the FOUNDRY SAND HANDBOOK.

Q. We are just beginning to investigate the cost of installing dust collecting equipment and wonder if there is any rule of thumb to guide us in determining the relative cost of the various types on the market?—K. R.

A. There are four basic types of cupola

emission collectors: 1) Electrostatic, 2) Fabric, 3) Centrifugal, and 4) Wet. The installation costs can best be compared by reducing costs to a common denominator of cubic feet per minute of standard tuyere air handled. On this basis the four types would cost, respectively, \$10, \$9, \$7 and \$6 per cfm of standard tuyere air passing through the collector. For a cupola with a 30 ton per hr melting rate, the installation costs for the four types would be approximately \$130,000, \$117,000, \$91,000, and \$78,000.

Q. If you were going to install heat treating equipment for aluminum castings in your foundry what type of furnace would you prefer? The high prices being charged by our local heat treating sources is forcing us to



consider putting in our own heat treating department—W. L. R.

A. If electric power costs are not too far out of line with other fuels in your locale I would certainly recommend that you install electrically heated furnaces. Since aluminum castings are heat treated at relatively low temperatures and the temperature control is critical—plus or minus 10 degrees usually—the furnace should be equipped with forced air circulation by a high temperature fan to insure that all castings in a furnace



load will be heated to the same temperature. Such a recirculating type of furnace is especially important when giving castings a precipitation heat treatment where temperature control is very important. Fused salt baths are a very efficient medium for solution heat treating of aluminum but tend to be a little on the expensive side. Salt baths provide high heating rates and easily controlled uniform temperatures.

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Circle No. 778, Page 7-8

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- 3 Includes a glossary
- 4 Includes a bibliography
- 5 259 pages . . . 93 illustrations

CHAPTERS COVER: Methods for Determining Fineness of Foundry Sands . . . Determining Moisture in Foundry Sand . . . Determination of Permeability of Foundry Sands . . . Strength of Foundry Sand Mixtures . . . Method for Determination of Green Surface Hardness—etc.

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Golf & Wolf Roads, Des Plaines, Ill.
Circle No. 779, Page 7-8

Let's Get Personal

Continued from page 133

of the Iowa Malleable Iron Co., Fairfield, Iowa. Other appointments are: Jack Calhoun, auditor and assistant treasurer, and R. K. Eaton, sales staff. Eaton will assist D. J. White, president of Everstick Anchor Co., a subsidiary of Iowa Malleable.

Arthur Neiman . . . Sipi Metals Corp., Chicago, is the company's new Cleveland district manager.

A. S. Glidewell . . . has been promoted to general superintendent of production, Foundries Div., Jackson Industries, Birmingham, Ala. He was formerly foundry superintendent. Glidewell is a member of the AFS Birmingham District Chapter.

R. S. Hull . . . is now New England sales representative, Springfield Facing, Inc., Willimansett, Mass. He succeeds A. S. Wright who has retired after serving the company for eight years. Hull was formerly with Aluminum Co. of America and the Foundry Products Dept., Borden Co., New York.

J. H. Moore . . . has been named general manager, NRC Equipment Corp., Newton, Mass., subsidiary of National Research Corp. Newton Highlands, Mass. He will be responsible for development, production, and sales of the company's high vacuum equipment. In addition, H. D. Stone has been appointed to the managerial staff of the wholly owned subsidiary.

J. H. Cadieux . . . has been named vice-president of Casting Engineers Inc., Chicago. He was formerly vice-president of Misco Precision Casting Co., Whitehall, Mich. Cadieux will direct all company manufacturing operations.

D. T. Martin . . . is a new member of the sales staff, Campbell, Wyant & Cannon Foundry Co., Muskegon, Mich. He has been associated with the Central Foundry Div., General Motors Corp. for 21 years.

Dr. D. J. McPherson . . . has recently been appointed manager, metals research department, Armour Research Foundation, Illinois Institute of Technology, Chicago. Formerly assistant manager of the metals department, he succeeds R. A. Lubker, who is now director of research, Alan Wood Steel Co., Conshohocken, Pa. D. W. Levinson is the new assistant manager. McPherson will be in charge of the Foundation's research in



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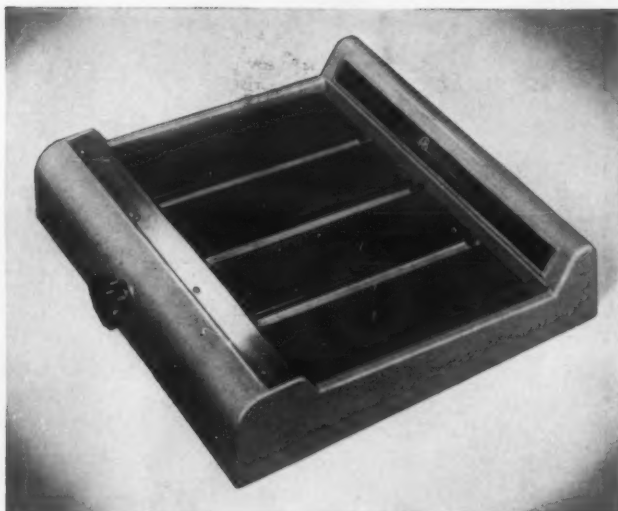
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Circle No. 780, Page 7-8



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Circle No. 781, Page 7-8

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Circle No. 782, Page 7-8

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Circle No. 783, Page 7-8

foundry and steelmaking, among other fields. Before joining this staff, he served as associate metallurgist at Argonne National Laboratory.

Harry Blumenthal . . . is the new executive vice-president, American Iron & Supply Co., Minneapolis.

S. J. Sitarz . . . Prospect Foundry Inc., Minneapolis, has been elected president of the firm. He was formerly manager.

Porter Warner, Jr. . . is now president, Porter Warner Industries Inc., Chattanooga, Tenn.

Joseph Roman . . . has been appointed vice-president in addition to his position as plant superintendent for Aelco Brass Foundry, Inc., Milwaukee.

Don LaVelle . . . is now research metallurgist, Central Research Laboratories, American Smelting & Refining Co., South Plainfield, N. J. He was formerly with Kaiser Aluminum, Chemical Sales, Inc., Chicago. LaVelle is currently serving as chairman of the AFS Light Metals Division.

T. E. Ward . . . president and general manager, Badger Malleable & Mfg. Co., South Milwaukee, Wis., has retired. He was an active member of the AFS Wisconsin Chapter.

G. H. Pitts . . . was elected vice-president of manufacturing, Bohn Aluminum & Brass Corp., Detroit. He will oversee all manufacturing operations of the company's ten plants located in Michigan, Indiana, and Illinois. Pitts has been associated with the corporation since 1950.

R. C. Penner . . . is now a partner, Interstate Supply & Equipment Co., Milwaukee. He formerly was president.

H. E. Erf . . . is the new Chicago district sales manager for Sterling Grinding Wheel Co., Tiffin, Ohio. He was formerly manager, sales administration for the firm.

J. W. Lauder . . . is now treasurer, Aurora Metal Co., Aurora, Ill. He also retains the title of vice-president.

L. D. Morton . . . has been appointed general superintendent, Wilputte Coke Oven Div., Allied Chemical & Dye Corp., New York. He has been associated with the coke oven industry since 1917, and was superintendent of construction of the first modern coke plant in India during 1920-1923.

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RESEARCH METALLURGIST: Midwestern research laboratory conducting program on direct reduction of iron ores for iron-base foundry alloy development. Training and experience should be compatible with eventually assuming program leadership. Excellent opportunity for technical and responsibility growth. Box E-17, **MODERN CASTINGS**, Golf and Wolf Roads, Des Plaines, Ill.

Foundry alloys salesman to contact iron and steel foundry to sell ferro-alloys in Midwest. Salary. Furnished resume including age, education, and experience. Box E-22, **MODERN CASTINGS**, Golf and Wolf Roads, Des Plaines, Ill.

Manufacturers require agent in all parts of the U.S. Principals at Cleveland in May. Box No. E-25, **MODERN CASTINGS**, Golf and Wolf Roads, Des Plaines, Ill.

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Widespread organization of international reputation seeks competent, metallurgically trained man experienced in cast metals and general engineering for responsible position as Technical Assistant. Will be charged with development of research projects, coordination of broad technical program and relations with engineers and technicians. Progressive organization, excellent opportunity advancement. Some travel. Write full details, personal background and qualifications, compensation required. Replies confidential. Box E-14, **MODERN CASTINGS**, Golf and Wolf Roads, Des Plaines, Ill.

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FOUNDRY METALLURGIST, BS in Metallurgical Engineering 1963, 5 years experience seeks position with greater responsibilities in medium-sized gray iron foundry. Experience includes casting development, cupola practice, sand control, and heat treating. Box E-20, **MODERN CASTINGS**, Golf and Wolf Roads, Des Plaines, Ill.

SUPERINTENDENT OR MANAGER—Young foundryman thoroughly versed in all gray iron operations. Degree in Metallurgical Engineering. Interested in responsible position with opportunity. Box No. E-23, **MODERN CASTINGS**, Golf and Wolf Roads, Des Plaines, Ill.

SAND SPECIALIST — experienced in ferrous metals, sand control, and development work. Supervised plant and laboratory sand operations. Technical background and experience in CO₂ process. Served foundry apprenticeship, college education. Age 33. Resume on request. Box E-19, **MODERN CASTINGS**, Golf and Wolf Roads, Des Plaines, Ill.

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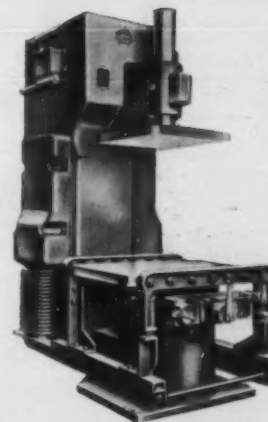
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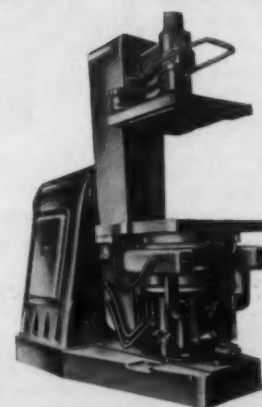
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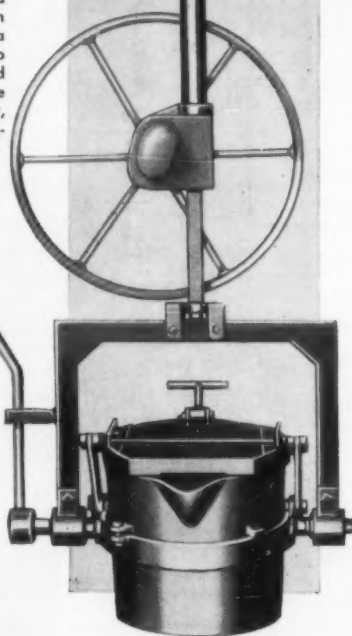
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Circle No. 785, Page 7-8

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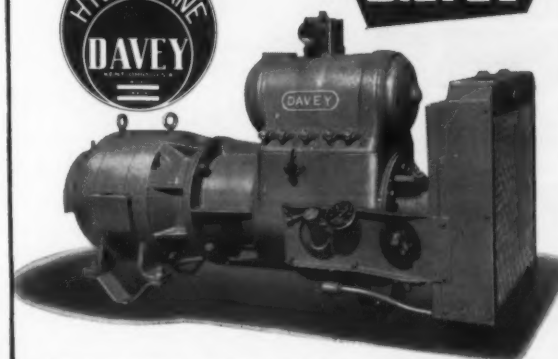
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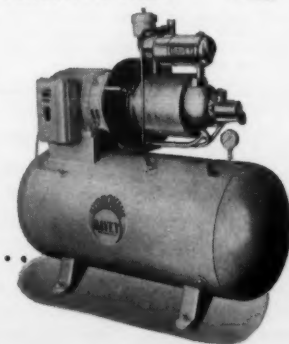
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